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The Tessellattice of Mother-Space as a Source and Generator of Matter and Physical Laws

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Real physical space is derived from a mathematical space constructed as a tessellation lattice of primary balls, or superparticles. Mathematical characteristics, such as distance, surface and volume, generate in the fractal tessellation lattice the basic physical notions (mass, particle, the particle's de Broglie wavelength and so on) and the corresponding fundamental physical laws. Submicroscopic mechanics developed in the tessellattice easily results in the conventional quantum mechanical formalism at a larger atomic scale and Newton's gravitational law at a macroscopic scale.

1. Introduction

Although Poincaré (1905a) was the first to write the relativistic transformation law for charge density and velocity of motion, Einstein's (1905) special relativity article received wide recognition, perhaps due to his introduction of a radically new abstract approach to fundamentals, which then culminated in his famous theory of general relativity (Einstein, 1916). Due to its predictions, which were verified experimentally, abstract theoretical concepts took root in the minds of a majority of physicists. Einstein's approach resembled rather a generalized description that descended to particulars through a series of postulated axioms. His general relativity considers how matter and geometry, constructed in empty space, coexist and influence each other, though matter is not an intrinsic property of space.

Einstein's thoughts regarding an aether were expressed in his well-known lecture (Einstein, 1920). He noted that since space was endowed with physical qualities, an aether must exist. Then he mentioned that, according to general relativity, space without an aether is unthinkable (light would not propagate; there would not any space-time intervals in the physical sense, *etc.*). Nevertheless, Einstein stressed that this aether might not be thought of as endowed with quality characteristic of a ponderable medium, consisting of parts that might be tracked through time. However, the basic issue remained: Why could the aether not be associated with a substrate? This was never clarified by Einstein completely.

The hypothesis of an aether as a material substrate responsible for electromagnetic wave propagation has been tested by many researchers (Miller, 1933; Essen, 1955; Azjukowski, 1993). A new optical method of the first order was proposed and implemented by Galaev (2002) for measurements of the aether-drift velocity and kinematic viscosity of aether. Galaev's results correlate well with the results of other researchers quoted above.

Observability, reproducibility and repeatability of aether drift effects have been conducted in various geographical conditions using different methods of measurement and in various ranges of electromagnetic waves. Overall, this research strongly supports the idea that the aether is a subsrate responsible for propagation of electromagnetic waves. These studies shed light on the negative results of aether wind measurements by Michelson and Morley: Their tool had too low a sensitivity.

Other researchers demonstrated direct interaction of matter with a subquantum medium. In particular, the influence of a new "strange" physical field on test subjects has been shown by Baurov (2002), Benford (2002) and Urutskoev *et al.* (2002). Similar effects are described by Shipov (1997), though the changes in samples examined were associated with the so-called "torsion radiation" introduced by Shipov as a primary field that allegedly dominated over a vague physical vacuum long before its creation. One more incomprehensible phenomenon is the Kozyrev effect (Kozyrev and Nasonov, 1978) whereby a bolometer centrally located in the focal point of a telescope records a signal from a star much earlier than the light signal hits the focal point.

Let us briefly examine Poincaré's studies. His research was also highly abstract, especially his investigations in mathematics and mathematical physics. Nevertheless, in physics applications, he tried to hold to natural laws as closely as possible. In fact, Poincaré (1905b, 1906) believed any new success in science was further support of determinism. In his works, he tried to start from a few details, which should then disclose the problem as a whole. Poincaré (1905b) strongly supported the idea of an aether, as he considered the motion of a particle to be accompanied by an aether perturbation. The idea of perturbation of the aether by a moving object was predominant among leading mathematicians and physicists up to beginning of the 20th century.

Therefore, his idea deserves credit (if any kind of aether in fact exists). Poincaré treated particles as peculiar points in the aether, though he did not develop further ideas on its construction nor principles of the motion of material objects in it. Experimental facts were not abundant at that time, and theoretical notions of condensed matter physics, which would help one to look at a possible theory of aether in more detail, were lacking. Moreover, mathematical methods of description of space were also in an embryonic state at beginning of the 20th century, despite the fact it was Poincaré who proposed and developed new concepts and methods of the investigation of space as such. At that time, data were not so numerous as now, and this did not allow Poincaré to consolidate ideas on space and aether in a unified generalized concept of real space.

However, today when abundant data are available, we may try to look at the possibility of unifying mathematical and physical ideas to incorporate an aether into space in one unified object of comprehensive study.

2. The constitution of space

Many researchers are involved in the search for a theory of everything (TOE). However, do we yet have a "theory of something"? The problem was studied by Bounias (2000) on the basis of pure mathematical principles. He firmly believed the ultimate theory might be some mathematical principle.

Following Bounias (2000), and Bounias and Krasnoholovets (2002, 2003), we can explore the problem of the constitution of space in terms of topology, set theory and fractal geometry. Evidently, according to set theory, only the empty set (denoted $\varnothing$) can represent nearly nothing. If *F* is a part of *E*, then the remaining part of *E*, which does not contain *F*, is the complementary of *F* in *E*, which is denoted $\complement_E(F)$. The empty set $\varnothing$ is contained in any set *E*, *i.e.* $\complement_E(E) = \{\varnothing, E\}$, then $\complement_E(E) = \varnothing$. This result, together with $\complement_E(\varnothing) = E$, is known as the first law of Morgan. This allowed Bounias to conclude the complement of the empty set is the empty set: $\complement_\varnothing(\varnothing) = \varnothing$. Following von Neumann, Bounias considered an ordered set, $\{\{\{\varnothing,\{\varnothing\}\},\{\varnothing,\{\varnothing,\{\varnothing\}\}$, and so on. By examining the set, one can count its members: $\varnothing =$ zero, $\{\{\varnothing\},\{\varnothing\}\} =$ one and *etc*. This is the empty set as long as it consists of empty members and parts. On the other hand, it has the same number of members as the set of natural integers, $N = \{0, 1, 2, ..., n\}$. Although it is proper that reality is not reduced to enumeration, empty sets give rise to mathematical space, which in turn brings about physical space. So, *something* can emerge from emptiness.

The empty set is contained in itself, hence it is a non-well-founded set, or hyperset, or empty hyperset. Any parts of the empty hyperset are identical, either a large part $(\varnothing)$ or the singleton $\{\varnothing\}$; the union of empty sets is also the same: $\varnothing \cup (\varnothing) \cup \{\varnothing\} \cup \{\varnothing,\{\varnothing\}\} \cup \ \{\varnothing,\{\varnothing\},\{\varnothing,\{\varnothing,\{\varnothing\}\}\} \cup ... = \varnothing$. This is the major characteristic of a fractal structure, which means the self-similarity at all scales (in physical terms, from the elementary sub-atomic level to cosmic sizes). One empty set $\varnothing$ can be subdivided into to two others; two empty sets generate something $(\varnothing) \cup (\varnothing)$ that is larger than the initial element. Consequently, the coefficient of similarity is $\rho \in [\frac{1}{2}, 1]$. In other words, ρ realizes fragmentation when it falls within the interval $]\frac{1}{2}, 1[$ and union when ρ with the interval $]0, \frac{1}{2}]$ yields $]0, 1[$. The coefficient of similarity allows us to estimate the fractal dimension of the empty hyperset, which owing to the interval $]0, 1[$ becomes a fuzzy dimension.

Time can be called *nothing*, because it is a singleton that does not have parts (otherwise it will be in contradiction to the definition of time as such). The nothingness singleton $(\in)$ is absolute unique. It is the lowest boundary of everything existing; this is the infimum of existence.

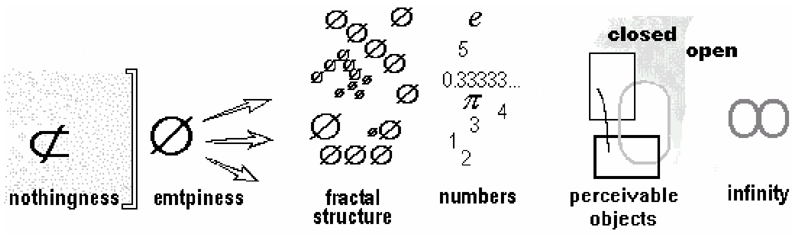

Figure 1. Range of things, from non-existence to something empty whose structure gives rise to something non-empty and up to infinity (from Bounias and Krasnoholovets, 2002).

4-D mathematical spaces have parts in common with 3-D spaces, which yields 3-D closed structures. There are then parts in common with 2-D, 1-D and zero dimension (points). General topology indicates the origin of time, which should be treated as an assembly of sections S_i of open sets. Indeed, fractality of space generates fuzzy dimensions (Bounias and Krasnoholovets, 2003a), and hence a common part of a pair of open sets W_m and W_n with different dimensions m and n also accumulates points of the open space. If $m > n$, then those points, which belong to W_m and would not belong to the section of the given sets, cannot be included in a *x*-D object. Bounias and Krasnoholovets (2002) exemplified this in the following way: "You cannot put a pot into a sheet without changing the shape of the 2-D sheet into a 3-D packet. Only a 2-D slice of the pot can be a part of a sheet." Therefore, infinitely many slices, *i.e.* a new subset of sections with dimensionality from 0 to 3, ensure the raw universe in its timeless form.

Thus a physical space is one that can be provided by closed intersections (timeless Poincaré sections) of abstract mathematical spaces. What happens to these sections S_i that all belong to an embedding 4-space? A series of sections S_i, S_{i+1}, S_{i+2}, *etc.* resembles the successive images of a movie, and only nothing does not move. Therefore, the difference of distribution of objects within two corresponding sections will mean a detectable increment of time. Hence time will emerge from order relations holding on these sections.

Two successive slices show a characteristic of mathematical objects from one to the next section. In other words, this is a mapping. The first section produces some *x* that then becomes $f(x)$ on the next one. The mapping between nearest sections can be treated in the framework of an indicatrix function $1(x)$ and Uryson's theorem. By definition, $1(x)$ for any *x* state yields $1(x) = 0$ if *x* has one property and $1(x) = 1$ if *x* has an alternative property. A combination of $f(x)$ with $1(f(x))$ makes a demonstration whose result depends upon whether the variable *x* belongs to one part of the frame in S_i or belongs to the same part in S_{i+1}. The complete function is a composition of the variables with their distribution. That is, the function has the structure of a moment, called a "moment of junction" *MJ* by Bounias (2000; Bounias and

Krasnoholovets 2003b). The function *MJ* describes the smallest increment of space. (One point is not at the same topological position for *MJ* to permit the change.) Such fine change of *MJ* also defines an increment in time—the minimal change. Since there is no thickness between two sections S_i and S_{i+1} the moment of junction *MJ* rigorously describes a differential element of space, which is also a differential element of time. This validates differential geometry from the description of the Universe.

3. Measure, distance, metric and objects

The concept of measure usually involves such particular features as existence of mappings and the indexation of collections of subsets on natural integers. Classically, a measure is a comparison of the measured object with some unit taken as a standard. The "unit used as a standard" is the part played by a gauge (*J*). A measure involves respective mappings on spaces, which must be provided with the rules $\cap$, $\cup$ and $\mathbf{C}$. According to Bonaly and Bounias (1996), in spaces of the R^n type, tessellation by balls is involved, which again requires a distance to be available for measurement of diameters of intervals. Intervals can be replaced by topological balls, and therefore evaluation of their diameter still needs an appropriate general definition of a distance. More comprehensive determinations of measure, distance, metric and objects, which involve topology, set theory and fractal geometry, have been made by Bounias and Krasnoholovets (2003a).

In physics, a ruler is called a metric. As a rule, mathematical spaces including topological spaces have been treated as not endowed with a metric, and properties of metric spaces have not been the same as those of non-metric spaces. However, in 1994 Bounias (see, *e.g.*, Bonaly and Bounias, 1996) have shown that a non-metric topological space does not exist! Indeed, union and intersection allow the introduction of the symmetric difference between two sets A_i and A_j

$$\Delta(A_i, A_j) = \mathop{\mathbf{C}}_{\cup\{A_i\}} \cup_{i \neq j} (A_i \cap A_j) \qquad (1)$$

i.e. the complementary of the intersection of these sets in their union. Symmetric difference satisfies the following properties: $\Delta(A_i, A_j) = 0$ if $A_i = A_j$, $\Delta(A_i, A_j) = \Delta(A_j, A_i)$ and $\Delta(A_i, A_j)$ is contained in union of $\Delta(A_i, A_j)$ and $\Delta(A_j, A_k)$. This means it is a true distance and can also be extended to the distance of three, four and *etc.* sets in one, namely, $\Delta(A_i, A_j, A_k, A_l, ...)$. Since the definition of a topology implies the definition such a set distance, every topological space is endowed with this set metric. The norm of the set metric is $\| A \| = \Delta(\varnothing, A)$. Therefore, all topological spaces are metric spaces, Δ-metric spaces, and they are measurable.

We now examine at the remaining part, *i.e.* the intersection of the sets. If they are of unequal dimensions, this intersection will be closed, *i.e.* the intersection in a closed space is closed, $\cup_{i \neq j}(A_i, A_j)$, which signifies the availability of physical objects. As distances Δ are the complementariness of objects, the system stands as a manifold of open and closed subparts. This procedure subdivides the Universe into two parts: the distances and the objects.

In general, we can imagine the universe as an immense drop containing N balls. Since measurement embraces such notions as length, surface and volume, we may represent ℓ—the loop distance of the universe (*i.e.*, the perimeter that can be measured with a ruler)—with parameters of the N balls. Indeed, let m be the measure of the balls (length, surface, or volume of dimension δ depending on what kind of the characteristics we are interested in). Inside a universe of dimension D we have N times m^{δ} approximately equal to ℓ^{D}, so that

$$D \sim (\delta \cdot \log m + \log N) / \log \ell. \qquad (2)$$

Thus if we know component parts of the universe, *i.e.* can describe sizes and shapes of the topological balls, we will be able to reconstruct the large unknown structure.

4. Tessellation lattice of primary balls

Let us now examine what space-time is in the approach proposed by Bounias and Krasnoholovets (2002, 2003). We started from the founding element. Namely, it is generally recognized in mathematics that some set does exist. A weaker form can be reduced to the existence of the empty set. If one provides the empty set $(\varnothing)$ with the combination rules $(\in, \subset)$ and the property of complementary $(\mathbf{C})$, a magma can be defined: The magma is a union of elements $(\varnothing)$, which act as the initiator polygon, and complementary $(\mathbf{C})$, which acts as the rule of construction; *i.e.*, the magma is the generator of the final structure. This allowed Bounias to formulate the following theorem: The magma $\varnothing^{\varnothing} = \{\varnothing, \mathbf{C}\}$ constructed with the empty hyperset and the axiom of availability is a fractal lattice. Writing $(\varnothing^{\varnothing})$ denotes the magma, and reflects the set of all self-mappings of $\varnothing$. The space, constructed with the empty set cells of the magma $\varnothing^{\varnothing}$, is a Boolean lattice, and this lattice $S(\varnothing)$ is provided with a topology of discrete space. A lattice of tessellation balls has been called a *tessellattice*, and hence the magma of empty hyperset becomes a fractal tessellattice.

Introduction of the lattice of empty sets ensures the existence of a physical-like space. In fact, the consequence of spaces (W_m), (W_n), ... formed as parts of the empty set $\varnothing$ shows that the intersections have non-equal dimensions, which gives rise to spaces containing all their accumulating points forming closed sets (Bounias and Krasnoholovets, 2003a). If morphisms are observed, then this enables the interpretation as a motion-like phenomenon, when one compares the state of a section with the state of mapped section. A space-time-like sequence of Poincaré sections is a non-linear convolution of morphisms. Our space-time then becomes one of the mathematically optimal morphisms, and time is an emergent parameter indexed on non-linear topological structures guaranteed by discrete sets. That is, the foundation of the concept of time is the existence of order relations in the sets of functions available in intersect sections.

Time is thus not a primary parameter, and the physical universe has no beginning: time is just related to ordered existence, not to existence itself. The topological space does not require any fundamental difference between reversible and steady-state phenomena, nor between reversible and irreversible process. Rather relations simply apply to non-linearily distributed topologies, and from rough to finest topologies.

Such fundamental notions as point, distance and similitude allow us to introduce relative scales in the empty-set lattice, *i.e.* the tessellattice; therefore space everywhere becomes quantized. Indeed, from mapping $G : N^D \mapsto Q$ of $(N \times N \times N \times ...)$ in Q we can identify a set of rational intervals. In this way, for n integers in each one of the 2-D spaces, $n \times n$, the pair $(1,\ n)$ yields fraction $1/n$ and the pair $(1,\ n-1)$ yields ratio $1/(n-1)$. Their distance is then the smaller interval, *i.e.* difference between these two fractions gives the smaller interval proportional to $1/n^2$, or more exactly, the interval $1/(n-1) - 1/n \ = 1/(n(n-1))$ that denotes a special scale limit depending on the size of the considered space (this smaller interval formed by n^2 grains is constructed from $\varnothing$). In 3-D, we will have interval $1/(n^2(n-1))$.

Predictable orders of size from $x = 1$ to $x = 60$ are clusters/universes whose objects range from 1 (the Planck scale, *i.e.* the size of an elementary cell of the tessellattice), to $\sim 10^{10}$ elementary cells (roughly quark-like size), to about 10^{17} cells (atomic size), to 10^{21} cells (molecular size), to 10^{28} (human size), to 10^{40} cells (solar system size) up to 10^{56} cells (largest structures). The universe offers a quite different organization of matter at different scales.

5. Generation of matter

Nowadays quantum and particle physics are considered as the most fundamental disciplines. They study the behavior of quantum systems, such as interaction between particles in the presence of this or that potential, transformations of particles to the others, *etc*. However, the fundamental notions with which quantum physics operates (mass, wave ψ- function, wave-particle, de Broglie and Compton wavelengths, spin and others) lack comprehension of their nature and origin, inasmuch as these microscopic parameters are *a priori* treated as primordial. This makes it possible to raise questions concerning conceptual difficulties of quantum mechanics (Krasnoholovets, 2004). Are we able to develop deeper first principles and derive fundamental notions based on a sub-microscopic concept? The “strangeness” of quantum mechanical behavior of particles must be completely clarified, owing to an inner determinism establishing specific links in quantum systems, which are hidden under the crude orthodox quantum formalism. In quantum electrodynamics, the electric and magnetic charges are not derived from first principles, and remain inconceivable observable points with special properties. In contrast, the sub-microscopic approach allows a rigorous mathematical study and clear definition of this notion (Krasnoholovets, 2003).

If we wish to provide insight into the structure of an abstract physical vacuum, we must rather assume that this substance is nothing, instead of complete emptiness. But nothing can be considered in terms of space, namely, topology, set theory and fractal geometry, which has just been demonstrated in the previous sections.

One of our starting points is the idea that organization of matter at the microscopic (atomic) level should reproduce submicroscopic space ordering. This means that the lattice of a crystal should be the reflection of the

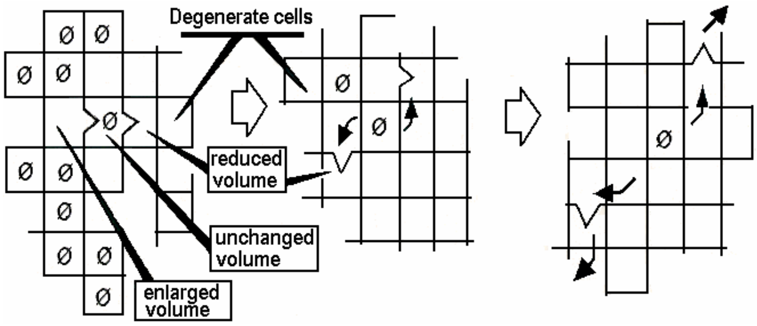

Figure 2. Volumetric fractality of cells as elementary deformations of the tessellattice. These deformations can occur with and without change in the volume of cells. Local deformations producing a reduction of the volume of cells are associated with the local generation of mass. These deformations can migrate in the tessellattice from cell to cell (from Bounias and Krasnoholovets, 2002).

arrangement of real physical space. This space can be fully associated with the tessellattice of densely packed balls, or superparticles. And this is the degenerate space (one may associate it with an abstract physical vacuum). Superparticles constitute founding cells of the tessellattice and are stacked without any unfilled place between them, which refers to the nothingness singleton, discussed in Section 2.

Degeneration of a cell is removed when the cell receives several deformations, such that its volume may be reduced, while the equivalent volume is redistributed among other cells (or in terms of conventional physics, the deformed superparticle becomes a massive particle), Figure 2. The mass m of this particle is the product of a constant C for dimensional analysis by ratio of the volume V of a superparticle to that of our reduced superparticle (which is now called the particle),

$$m = C\, V_{\text{super}} / V_{\text{part}} \,. \tag{3}$$

By analogy with the crystal lattice in which a foreign particle deforms the environment, we recognize that a deformation sheath emerges in the tessellattice around a canonical particle; the size of this sheath is associated with the particle's Compton wavelength (Figure 3).

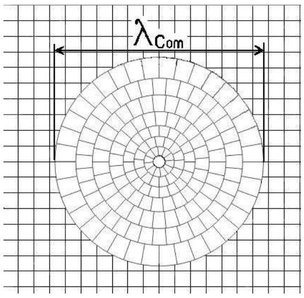

Figure 3. Particle as a local deformation of the tessellattice (the central cell) and the deformation coat that screens the particle from the degenerate tessellattice.

Having established the particle, we may try to construct its mechanics in tessellation space, which immediately means development of physical laws and physics in general. Since the space should be densely packed with balls, any motion of a chosen (deformed) ball should be expressed in terms of interaction with other balls of the space. This brings about a radically new approach to the behavior of matter.

6. The submicroscopic mechanics

Thus, the real space exists in the form of the tessellattice, *i.e.* tessellation lattice of primary balls (superparticles, or cells) that densely pack the universe. The submicroscopic mechanics of particles has been developed by the author in a series of works (see, *e.g.* Krasnoholovets, 2002a). A particle cannot move without rubbing against superparticles of the tessellattice, and hence a packet of lattice deformations goes forward accompanying the particle. Elementary excitations migrating from cell to cell in fact represent a resistance, *i.e.*, inertia, of the space constructed as the tessellattice. These excitations, called *inertons*, are produced at collision-like phenomena: deformations (inertons) go from the particle to the surrounding space and then due to elastic properties of the tessellattice some come back to the particle. This motion can be described by the appropriate Lagrangian (simplified here)

$$L = m\dot{x}^2/2 + \mu\dot{\chi}^2/2 - \sqrt{m\mu}\,\dot{x}\chi/T \qquad (4)$$

where m, x and μ, χ are the mass and position of the particle and its inerton cloud, respectively; $1/T$ is the frequency of collisions between the particle and the cloud.

The Euler-Lagrange equations indicate periodicity in the behavior of the particle. Consequently, the particle velocity oscillates between the initial value υ and zero along each section λ of the particle path. This spatial amplitude is determined as follows: $\lambda = \upsilon T$. The same occurs for the cloud of inertons: $\Lambda = cT$. These two amplitudes become connected by means of relationship $\Lambda = \lambda\, c/\upsilon$.

Furthermore, solutions to the equations of motion show that motion of the particle in the tessellattice is characterized by two de Broglie relationships for the particle: $E = h\nu$ and $\lambda = h/(m\upsilon)$ where $\nu = 1/(2T)$, and these allow the derivation of the Schrödinger equation. Therefore, at this stage submicroscopic mechanics passes into conventional quantum mechanics.

The amplitude of spatial oscillations of the particle λ appears in quantum mechanics as the de Broglie wavelength. The amplitude of the particle's cloud of inertons Λ becomes implicitly apparent through the availability of the wave ψ-function. Therefore, the physical meaning of the ψ-function becomes completely clear: it describes the range of space around the particle perturbed by its inertons.

The next step is that inertons transfer not only inertial, or quantum mechanical properties of particles, but also gravitational properties, because they transfer fragments of the deformation of space (*i.e.* mass) induced by the particle. Study (Krasnoholovets, 2002b) shows that the object's dynamic inertons allow the derivation of Newton's static gravitational law, as long as inertons spread as a standing spherical wave specified by the dependency $1/r$.

7. Concluding remarks

The mysteries of quantum mechanics are here explained in real space, and inertons have been experimentally detected in conditions predicted by the theory (see, *e.g.* Krasnoholovets, 2002a). The submicroscopic mechanics fully restores determinism. In addition, recently my colleagues and I have launched the project entitled “Inerton Astronomy,” in conjunction with which we have built a special laboratory facility able to measure inerton waves. We can now record inerton signals along the West-East line at ~20 Hz, which is associated with proper rotation of the globe. From September to December, 2004, we recorded a flow of inertons at frequencies from 18 to 22 kHz coming from the northern sky in a universal time interval from 3 p.m. to 5 p.m.

The concept of the tessellattice of space replaces such uncertain notions as classical elastic aether and physical vacuum. This deeper concept makes it possible to uncover many inner details of the constitution and behavior of particles and physical fields, which have thus far eluded researchers.

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