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The Space Structure, Force Fields and Quantum Mechanics

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Abstract. It is proposed that the cosmic digital code consists of 1 and 0 for an attachment space and a detachment space, respectively. The attachment space attaches to an object, while the detachment space detaches from the object. The cosmic digital code relates to the reduction of > 4D space-time into 4D space-time and the derivation of the space structure. Through the detachment space, > 4D space-time is sliced into infinitely many 4D slices surrounding the 4D core attachment space. The space structurally is a partition space, or a lattice space. The lattice space consists of repetitive units of alternative attachment space and detachment space and provides for a coherent wavefunction and gauge force fields, while the partition space consists of separated continuous phases of attachment space and detachment space providing the space structure for the collapse of wavefunction and the permanent detachment or attachment of gauge bosons. Thus, the wavefunction and gauge bosons become pure physical fields. The mechanism for the emergence of the space structure is varying dimension numbers, ensuring the metric for the slicing of > 4D space-time.

Key words: space structure, force fields, inertons, quantum mechanics

1 The space structure

The conventional explanation of the hidden extra space dimensions is the compactization of the extra space dimensions. For example, six space dimensions become hidden by the compactization, so space-time appears to be four dimensional. Bounias and Krasnoholovets (2003a) propose another explanation of the reduction of > 4 D space-time into 4D space-time by slicing > 4D space-time into infinitely many 4D slices surrounding the 4D core particle. Such slicing of > 4D space-time is like slicing 3-space D object into 2-space D object in the way stated by Michel Bounias as follows: "You cannot put a pot into a sheet without changing the shape of the 2-D sheet into a 3-D dimensional packet. Only a 2-D slice of the pot could be a part of sheet".

This paper proposes that the space structure for such reduction of > 4D space-time can also be derived from the cosmic digital code (Chung 2002a), which one can consider as "the law of all laws". The cosmic digital code consists of mutually exclusive attachment space and detachment space. Attachment space attaches to an object, while detachment space detaches from the object. The cosmic digital code is analogous to two-value digital code for computer with two mutually exclusive values: 1 and 0, representing *on* and *off*. In terms of the cosmic digital code, attachment space and detachment space are represented as 1 and 0, respectively. The object with > 4D space-time attaches to > 4D attachment space, which can be represented by

$$\left(i\,1_{3+k}\right)_m \text{ as } > 4\text{D attachment space with } m \text{ repetitive units of time } (i) \text{ and } 3+k \text{ space dimension.}$$

The slicing of > 4D attachment space is through 4D detachment space, represented by

$$\left(i\,0_3\right)_n \text{ as detachment space with } n \text{ repetitive units of time } (i) \text{ and three space dimension.}$$

The slicing of > 4D attachment space by 4D detachment space is the space-time dimension number reduction equation as follows

$$\underset{>4\text{D attachment space}}{\left(i\,1_{3+k}\right)_m} \xrightarrow{\textit{slicing}} \underset{\text{4D core attachment space}}{\left(i\,1_3\right)_m} + \underset{k \text{ types 4D slices}}{\sum_{k=1}^{k} \left(\left(i\,0_3\right)\left(i\,1_3\right)\right)_{n,k}} \qquad (1)$$

The two products of the slicing are the 4D-core attachment space and 4D slices represented by n repetitive units of alternative 4D attachment space and 4D detachment space. They are k types of 4D slices, representing the total number of space dimensions

greater than three-dimensional space. For example, the slicing of 10D attachment space produces 4D core attachment space and six types of 4D slices. The value of *n* approaches to infinite for infinitely many 4D slices.

The core attachment space surrounded by infinitely many 4D slices corresponds to the core particle surrounded by infinitely many small 4D particles. Gauge force fields are made of such small 4D particles surrounding the core particle. The space with repetitive units (of alternative attachment space and detachment space) is the lattice space (Bounias and Krasnoholovets, 2003a,b,c). The lattice space is for coherence that reflexes the coherence between a core particle and its surrounding force fields.

The universe suggests a quite different organization of matter at different scales (Bounias and Krasnoholovets, 2003b): on the Planck scale, ~ 10^{-35} m, the object range is one elementary cell of the tessellattice; on the quark scale spatial clusters embrace ~ 10^{10} of the tessellattice's cells; on the atomic size clusters of space cover about 10^{17} cells and so on. Therefore, the lattice space is also the space for a coherent single particle. One unit of the lattice space for a single canonical particle is its de Broglie wavelength, $\lambda = h / p$. It starts with pure attachment space and zero detachment space. Pure attachment space attaches to particle, resulting in zero velocity, while pure detachment space detaches from particle, resulting in υ_0. Thus, the unit of lattice spaces starts with zero velocity. Attachment space, then, gradually decreases to zero attachment space and pure detachment space, resulting in gradual increase in velocity from zero to υ_0. Detachment space, then, gradually decreases to zero detachment space and pure attachment space, resulting in gradual decrease in velocity from υ_0 to zero again for another unit of lattice space. All coherent systems travel in the lattice space. The result is the formation of wavefunctions. Therefore, the wave ψ-function acquires a pure physical meaning of a matter field, or the field of inertia whose carriers are quasi-particles of the lattice space called *inertons* (see e.g. Krasnoholovets (2002a), Bounias and Krasnoholovets (2003b)).

The lattice space described above is an average structure. The lattice space is not rigid, and can have fluctuations with uneven distribution of attachment space and detachment space, resulting in a density fluctuation, as a quantum fluctuation.

Another arrangement of attachment space and detachment space is a "partition space". The partition space consists of attachment space and detachment space in separated continuous phases. The partition space results from the collapse of the lattice space as the space collapse equation as follows.

$$\underset{\textit{lattice space}}{\left\langle\left\langle i\,0_3\right\rangle\left\langle i\,1_3\right\rangle\right\rangle_n} \xrightarrow{\textit{collapse}} \underset{\textit{partition space}}{\left\langle i\,0_3\right\rangle_n \left\langle i\,1_3\right\rangle_n} \qquad (2)$$

Partition space is for decoherence. Partition space reflexes the collapse of coherent system (wavefunction) by the entanglement of multiple different systems. Multiple different systems are not coherent, so attachment space and detachment space are separated into continuous phases. In partition space, attachment space attaches to particle according to its probability, while detachment space separately detaches from all probability density. All measurements involve entanglement, so they are done in partition space. We can

observe only the partition space, not the lattice space directly. Because of this collapse of the wavefunction, a system can be considered as a superposition of alternate states by their probabilities.

The space in between a core particle and its gauge force field is the lattice space consisting of repetitive appearances of alternative attachment space and detachment space. When detachment space appears in between the core particle and the gauge force field, it is the absorption of a gauge boson, such as the photon. On the other hand, when detachment space appears in between the core particle and the gauge force field, it is the emission of a gauge boson. The symmetry for such gauge force field is gauge symmetry. There is no net force from repetitively alternative absorption and emission of force carriers in global gauge symmetry. The net force in terms of local gauge symmetry is the result of the perturbation of force field. The perturbation causes a collapse of the lattice space, leading to the formation of partition space with the permanent absorption of a gauge boson by attachment space or the emission of a gauge boson by detachment space. Thus the repetitively alternative absorption and emission of force fields backs up an idea that submicroscopic deterministic quantum mechanics (Krasnoholovets, 2002a) is the origin for anticipatory processes revealed in electrodynamics and quantum mechanics by Dubois (2000a,b) who considered anticipation as an inner property of any quantum system, which should naturally be embedded in the system. Dubois constructed discrete forward and backward derivatives $\partial^{\pm}/\partial t$ that thus represented the absorption/emission of force fields.

In summary, the lattice space is the space for wavefunction in the space for individual particles, while the lattice space is the space for gauge symmetry in the space in between the core particle and the gauge force field. The space structure is not absolute. It depends on mass-energy, coherence-decoherence of individual particles and fractality of force fields.

Krasnoholovets (2002b) studied the appearance of gravity as a contraction of the tessellation space due to the propagation of inertons around an object: The object's inertons induce a mass field, i.e. distribute deformations of space resulting in its contraction, because by definition (Bounias and Krasnoholovets, 2003b) the notion of mass is associated with a local deformation of a tessellattice's cell.

If we do not deal with an inner mechanism of the gravitational field formation considering only a "frozen" state of the inerton field distribution, we may treat the gravitational force field as not a gauge force field. In this approximation the gravitational field involves only attachment space without detachment space. Such approximation allows the derivation of the gravitational force field from an attached extra dimension to 10D string to form 11D-membrane (Chung, 2002b). The attached dimension undergoes reversible and repetitive the contraction to the Planck distance and the expansion to infinite distance. This contraction-expansion reproduces the Planck-infinite dimension in the model of Randall and Sundrum (1999a,b,c) for gravity. When the expansion of one attached dimension is responded by the contraction of another attached dimension, these two dimensions attract with each other. On the other hand, when the expansion of one attached dimension is responded by the expansion of another attached string, these two attached dimensions repulse from each other.

2 The mechanism for the emergence of the space structure

The metric for the slicing of extra space dimensions can be provided by varying dimension numbers, which can be treated as a mechanism for the emergence of the space structure. Varying dimension numbers are derived from varying speed of light (VSL) theory (Amelino-Camelia, 2001,2002; Barrow, 2003; Ellis and Uzan, 2003; Magueijo, 2003). The constancy of the speed of light is the pillar of special relativity. It is believed the constancy of the speed of light takes place in the four dimensional space-time whose space-time dimension number (four) is constant, though Santilli (2005) presents contrary arguments demonstrating that the value of *c* is not a constant in vacuum too. In the model of cosmology (Albrecht and Magueijo, 1998; Barrow, 1999, 2003) that belongs to the VSL model, the speed of light varies in time. The time dependent speed of light varies as some power of the expansion scale factor *a* in such way that

$$c(t) = c_0\, a^n \tag{3}$$

where $c_0 > 0$ and *n* are constants. The increase of speed of light is continuous.

This paper posits quantized varying speed of light (QVSL), where the speed of light is invariant in a constant space-time dimension number, and the speed of light varies with varying space-time dimension number from 4 to 11. In QVSL, the speed of light is quantized by varying space-time dimension number

$$c_{\mathrm{D}} = c/\alpha^{\mathrm{D}-4}, \tag{4}$$

where *c* is the observed speed of light in the 4D space-time, c_{D} is the quantized varying speed of light in space-time dimension number, D, from 4 to 11, and α is the fine structure constant. Each dimensional space-time has a specific speed of light. The speed of light increases with the increasing space-time dimension number D. In the VDN model of cosmology, the universe starts with the pre-expanding universe that has the speed of light in 11D space-time.

In special relativity, $E = M_0 c^2$ modified by Eq. (4) is expressed as

$$E = M_0 (c^2/\alpha^{2(\mathrm{D}-4)}) \tag{5a}$$

$$= (M_0/\alpha^{2(\mathrm{d}-4)})\, c^2. \tag{5b}$$

Eq. (5a) means that a particle in the D dimensional space-time can have the superluminal speed $c/\alpha^{\mathrm{D}-4}$, which is higher than the observed speed of light *c*, and has the rest mass M_0. Eq. (5b) means that the same particle in the 4D space-time with the observed speed of light acquires $M_0/\alpha^{2(\mathrm{d}-4)}$ as the rest mass, where d = D. D in Eq. (5a) is the space-time dimension number defining the varying speed of light. In Eq. (5b), d from 4 to 11 is "mass dimension number" defining varying mass. For example, for D = 11, Eq. (5a) shows a superluminal particle in eleven-dimensional space-time, while Eq. (5b) shows that the

speed of light of the same particle is the observed speed of light with the 4D space-time, and the mass dimension is eleven. In other words, 11D space-time can transform into 4D space-time with 11d mass dimension. QVSL in terms of varying space-time dimension number, D, brings about varying mass in terms of varying mass dimension number, d.

The QVSL transformation transforms space-time dimension number and mass dimension number. In the QVSL transformation, the decrease in the speed of light leads to the decrease in space-time dimension number and the increase of mass in terms of increasing mass dimension number from 4 to 11.

$$c_{\mathrm{D}} = c_{\mathrm{D}-n} / \alpha^{2n}, \tag{6a}$$

$$M_{0,\mathrm{D},\mathrm{d}} = M_{0,\mathrm{D}-n,\ \mathrm{d}+n}\alpha^{2n}, \tag{6b}$$

$$\mathrm{D},\ \mathrm{d} \xrightarrow{QVSL} (\mathrm{D} \mp n),\ (\mathrm{d} \pm n) \tag{6c}$$

where D is the space-time dimension number from 4 to 11 and d is the mass dimension number from 4 to 11. For example, the QVSL transformation transforms a particle with 11D4d to a particle with 4D11d. In terms of rest mass, 11D space-time has 4d with the lowest rest mass, and 4D space-time has 11d with the highest rest mass.

The QVSL transformation is an alternative to the Higgs mechanism to gain rest mass. In the QVSL, the speed of light is constant in a specific space-time dimension number, such as 4 for our four-dimensional space-time. In different space-time dimension numbers (from 4 to 11), speeds of light are different. In our four-dimensional space-time, the speed of light is the lowest, so according to special relativity ($E = M_0 c^2$), with constant energy, the rest mass in our four-dimensional space-time is the highest. Thus, instead of absorbing the Higgs boson to gain rest mass, a particle can gain rest mass by decreasing the speed of light and space-time dimension number. The QVSL transformation also gains a new quantum number, "mass dimension number" from 4 to 11 to explain the hierarchical masses of elementary particles. Since the Higgs bosons have not been found experimentally, the QVSL transformation to gain rest mass is a good alternative. In terms of vacuum energy, the four-dimensional space-time has the zero vacuum energy (all superparticles that compose the tessellattice are found in the degenerate state) with the highest rest mass, while D > 4 have non-zero vacuum energy with lower rest mass than 4D. Since the speed of light for a > 4D particle is greater than the speed of light for a 4D particle, the observation of > 4D particles by 4D particles violates casualty. Thus, > 4D particles are hidden particles with respect to 4D particles. Such hidden particles form the base for phantom energy (Caldwell, 2002; Gibbons, 2003; Yurov, 2003; Barrow, 2004; Feng et al. 2004; Guo, Piao and Zhang, 2004; Zhang, 2004) and the hidden universe. In general, particles with different space-time dimensions are transparent and oblivious to one another.

Attachment space includes the fermion space attaching to a fermion and the boson space attaching to a boson. In the normal supersymmetry transformation, the repeated application of the fermion-boson transformation transforms a boson (or fermion) from one point to the same boson (or fermion) at another point at the same mass. In the "varying supersymmetry transformation", the repeated application of the fermion-boson

transformation transforms a boson from one point to the boson at another point at different mass dimension number in the same space-time number. The repeated varying supersymmetry transformation transforms a boson B_d into a fermion F_d and a fermion F_d to a boson B_{d-1}, which can be expressed as follows

$$M_{\mathrm{d,F}} = M_{\mathrm{d,B}}\, \alpha_{\mathrm{d,B}}, \tag{7a}$$

$$M_{\mathrm{d-1,B}} = M_{\mathrm{d,F}}\, \alpha_{\mathrm{d,F}}, \tag{7b}$$

where $M_{\mathrm{d,B}}$ and $M_{\mathrm{d,F}}$ are the masses for a boson and a fermion, respectively, d is the mass dimension number, and $\alpha_{\mathrm{d,B}}$ or $\alpha_{\mathrm{d,F}}$ is the fine structure constant that is the ratio between the masses of a boson and its fermionic partner. Assuming $\alpha_{\mathrm{d,B}}$ or $\alpha_{\mathrm{d,F}}$, the relation between the bosons in the adjacent dimensions, then, can be expressed as

$$M_{\mathrm{d-1,B}} = M_{\mathrm{d,B}}\, \alpha_{\mathrm{d}}^2, \tag{7c}$$

Eqs. (7) shows that it is possible to describe mass dimensions > 4 in terms of

$$\mathrm{F_5\, B_5\, F_6\, B_6\, F_7\, B_7\, F_8\, B_8\, F_9\, B_9\, F_{10}\, B_{10}\, F_{11}\, B_{11}}, \tag{8}$$

where the energy of B_{11} is the Planck energy. Each mass dimension between 4d and 11d consists of a boson and a fermion. Eq. (7) shows a stepwise transformation that transforms a particle with d mass dimension to d ± 1 mass dimension. The transformation from a higher dimensional particle to the adjacent lower dimensional particle is the fractionalization of the higher dimensional particle to the many lower dimensional particle in such way that the number of lower dimensional particles becomes $n_{\mathrm{d\text{-}1}} = n_{\mathrm{d}} / \alpha^2$. The transformation from lower dimensional particles to higher dimensional particle is a condensation. Both the fractionalization and the condensation are stepwise. For example, a particle with 4D (space-time) 10d (mass dimension) can transform stepwise into 4D9d particles. Since the supersymmetry transformation involves translation, this stepwise varying supersymmetry transformation leads to a translational fractionalization and translational condensation, resulting in expansion and contraction. At the same time it should be mentioned that research by Krasnoholovets (2000) points out to the fact that only fermions are true canonical particles, while bosons are rather combined particles consisting of fermions. This was proven for the real physical space, although other authors establish a simply fact that the procedure of integrating pairs of fermions results in a ‘bosonization’ (Friedan, Martinec and Shenker, 1986).

Another type of the varying supersymmetry transformation is not stepwise. It is the leaping varying supersymmetry transformation that transforms a particle with d mass dimension to any d ± n mass dimension. The transformation involves the slicing-fusion of particle. The transformation from d to d – n involves the slicing of a particle with d mass dimension into two parts: the core particle with d – n dimension and the n dimensions that are separable from the core particle. Such n dimensions are denoted as n "dimensional orbitals", which become force fields (Chung 2002b). The sum of the number of mass dimensions for a particle and the number of dimensional orbitals is equal to 11 for all particles with mass dimensions. Therefore,

$$F_d = F_{d-n} + (11 - d + n)\,DO's \tag{9}$$

where $11 - d + n$ is the number of dimensional orbitals (DO's) for F_{d-n}. For example, the slicing of 4D9d particle produces 4D4d particle that has d = 4 core particle and 7 separable dimensional orbitals in the form of $B_5F_5B_6F_6B_7F_7B_8F_8B_9F_9B_{10}F_{10}B_{11}$. Since the slicing process is not stepwise from higher mass dimension to lower mass dimension, it is possible to have simultaneous slicing. For example, 4D9d particles can simultaneously transform into 4D8d, 4D7d, 4D6d, 4D5d, and 4D4d core particles, which have 3, 4, 5, 6, and 7 separable dimensional orbitals, respectively. Therefore, varying supersymmetry transformation can be stepwise or leaping. Stepwise supersymmetry transformation is translational fractionalization and condensation, resulting in stepwise expansion and contraction. Leaping supersymmetry transformation is not translational, and it is slicing and fusion, resulting possibly in simultaneous formation of different particles with separable dimensional orbitals.

In summary, the QVSL transformation transforms space-time dimension number and mass dimension number. The varying supersymmetry transforms varying mass dimension number in the same space-time number as follows (D = space-time dimension number and d = mass dimension number).

$$D,\ d \xrightarrow{QVSL} (D \mp n),\ (d \pm n)$$

$$D,\ d \xrightarrow{stepwise\ \ or\ \ leaping\ \ \ varying\ \ supersymmetry} D,\ (d \pm 1)\ \ or\ \ D, (d \pm n)$$

Chung (2002b) proposed that the primitive multiverse started with 10D strings. Before the inflation, our observable universe was made of particles (not strings) as 10D4d with another dimension for gravity. 10D4d particle transforms through the quick QVSL transformation quickly into 4D10d particles, which then transform and fractionalize quickly through varying supersymmetry transformation into 4D9d, resulting in an inflationary expansion (Guth 1981; Linde, 1982; Albrecht and Steinhardt, 1982; Chung, 2002b). The inflationary expansion occurs between the energy for 4D10d = $E_{Planck}\,\alpha^2$ = 6 x 10^{14} GeV and the energy for 4D9d = E_{10}, $\alpha^2 = 3\times10^{10}$ GeV. At the end of the inflationary expansion, all 4D9d particles undergo simultaneous slicing to generate equally by mass and number into

4D9d, 4D8d, 4D7d, 4D6d, 4D5d, and 4D4d core particles. Baryonic matter is 4D4d, while dark matter consists of the other five types of particles. The mass ratio of dark matter to baryonic matter is 5 to 1 in agreement with the observation (Rees, 2003) showing the universe consists of 25% dark matter, 5% baryonic matter, and 70% dark energy. Dark matter contributes to the inhomogeneous structure of baryonic matter (Chung 2002b).

Chung (2002b) hypothesized that the dark energy (D = 4) comes from the hidden universe (D > 4). The hidden universe is the companion universe to our observable universe, and undergoes only the slow stepwise QVSL transformation and the stepwise varying transformation from 10D4d instead of the quick QVSL transformation and the simultaneous slicing as in the observable universe. Afterward, thermal expansion (the big bang) takes place in the observable universe. In summary, the processes for the observable universes and the hidden universe are as follows

The Observable Universe

$$10\text{D4d} \xrightarrow{\textit{quick QVSL transformation}} 4\text{D10d} \xrightarrow{\textit{stepwise varying supersymmetry, inflation}}$$

$$4\text{D9d} \xrightarrow{\textit{simultaneous slicing}} \textit{dark matter}(4\text{D9d} + 4\text{D8d} + 4\text{D7d} + 4\text{D6d} + 4\text{D5d})$$

$$+ \textit{baryonic matter}(4\text{D4d}) + \textit{cosmic radiation} \rightarrow \textit{thermal cosmic expansion}(\textit{the big bang})$$

The Hidden Universe and Dark Energy

$$10\text{D4d} \rightarrow 9\text{D5d} \rightarrow 9\text{D4d} \rightarrow 8\text{D5d} \rightarrow 8\text{D4d} \rightarrow 7\text{D5d} \rightarrow \cdots \rightarrow 5\text{D4d} \rightarrow 4\text{D5d} \rightarrow 4\text{D4d}$$

$$\mapsto \qquad \textit{the hidden universe} \qquad \leftrightarrow\!\!\rightarrow \textit{dark energy} \leftarrow$$

The mechanism for the slicing into core particle and dimensional orbital requires detachment space that detaches core particle and its dimensional orbitals, which become force fields. In varying dimension number, the slicing is the slicing of mass dimension rather than the slicing of space-time dimension directly. It can be shown that for baryonic matter the mass dimension number reduction equation becomes

$$\left(1_{4+k}\right)_m \xrightarrow{\textit{slicing}} \left(1_4\right)_m + \sum_{k=1}^{k} \left(\left(0_4\right)\left(1_4\right)\right)_{n,k} \qquad (10)$$

$4\text{D} > 4\text{d}$ *attachment space* 4D4d *core attachment space* k *types* 4D4d *slices*

where 4 and $k = 6$ (for six gauge force fields) are d rather than D.

3 Summary

In summary, the cosmic digital code consists of 1 and 0 for attachment space attaching to an object and detachment space detaching from the object, respectively. Through detachment space, the reduction of > 4D space-time into 4D space-time is by the slicing of > 4D space-time into infinitely many (a typical empty hyperset!) 4D slices surrounding the 4D space-time core attachment space. The space structure for such reduction of > 4D space-time is the lattice space consisting of repetitive units of alternative attachment space and detachment space. Attachment space attaches to the core 4D particle and 4D slices, separated from one another with detachment space. The result is the lattice space. 4D slices surrounding the core 4D particle are gauge force fields. The lattice space is for coherence. It is the space for wavefunction of single particle, and is the space for gauge symmetry between the core particle and its gauge force field. The collapse of the lattice space leads to a partition space consisting of attachment space and detachment space in separated continuous phases. The space structure is not absolute depending on mass-energy and coherence-decoherence of a particle.

The mechanism for the emergence of the space structure is varying dimension numbers (VDN), providing the metrics for the slicing of > 4D space-time. VDN is derived from the varying speed of light (VSL). In VDN, the speed of light increases with increasing space-time dimension number (D), decreasing mass dimension number (d), decreasing rest mass, and increasing vacuum energy. In Chung (2002a,b) model, the primitive multiverse starts with 10D strings. Before the inflation, our observable universe started with the 4D10d particles with another dimension for gravity. The slicing of d dimensions results in the 4D4d core particles and 4D4d slices for baryonic matter. In varying dimension numbers, the slicing is the slicing of mass dimension rather than the direct slice of space-time dimension. Baryonic matter has the 4D4d core particles surrounding by six different types of 4D4d slices, which represents six different gauge force fields.

Our discussion of processes is also a new result in physics, which shows an interrelation between sub microscopic structure of physical systems and the systems dynamics.

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