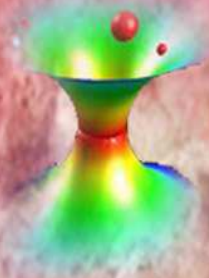
V.A.Kasimov



The emergence of spatio-temporal certainty (1 +2 +3)

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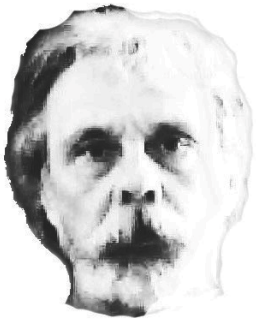
Some philosophical problems spatial-temporal relationships

V. A. Kasimov (E-mail: quadrica-m@mail.ru)[1)]

"Ontologization"[2)]



The well - known philosophical formula: space and time-the universal forms of existence of matter, forces us to introduce several levels of representation of our knowledge about space-time relations, which we will conditionally call the levels of ontologization of our understanding of these relations. These levels can be considered as ontological slices in the process of cognition of the essence of spatiotemporal relations and the formation of their conceptual certainty.

Zero level. The level of reflection of the all-encompassing being and the entities filling it. At the zero level of ontologization the World (World = Universe, by definition), as an integral entity (universe), has neither beginning nor end, nor age, and exists out the space-time aspect, because it is the primary concept introduced before the subsequent factorization.

First level. Conceptual certainty of a comprehensive being begins with its factorization into *existence* (it is forerunner causal or temporal ordering of the states of the entity in the formation under the influence of other entities) and *coexistence* (it is forerunner spatial relations, that is, the independent presence of entities in the global existence without mutual influence on each other). At this level of certainty of existence in change (evolution) and coexistence without mutual influence, one can already talk about the physical *arising* of entities (worlds), their independent coexistence and the end of their stay in existence.

Second level. Separability and distinctiveness of objects in individual existence and co-existence (for example, thoughts in the head of an individual; quantum objects, each of which is described by a single wave function (including the many-particles systems); brans in a space of greater dimension, etc.). Although the distinctiveness and separability of entities are fixed here, the degree of proximity or topology of relations of objects is not formalized here.

It is difficult to doubt the phenomenon of the existence of thoughts in the human mind. The very same thought is a neurochemical process, which has a beginning (the emergence of thought), evolves (develops) and ends with a certain design of the result of reflection in the form of a certain conclusion, ready for some decision. Several thoughts can coexist, although their localization is ephemeral and illusory. However, we can say that the thoughts of different people located in different skull. On this particular example, we illustrate the possibility of the existence of separate and distinct entities in existence and coexistence, but not quite in the space-time aspect.

Third level. The current state of physics distinguishes three hypostases of physical existence for the detachable essence of the second level*: micro-*, *macro-* and *mega-*. They represent today the main *"hierarchical"* levels of organization of matter [3)].

Since ancient times, it has been believed that physics is the science of what we "see", observe, that is, that in a sense is the subject of *macro−*. And the meaning of rational cognition of Nature is to speak, explain and predict "visible" phenomena in accordance with experience. Obviously, in this case the *micro-* and *mega-* concepts must necessarily be "projected" onto the *macro-*. This is the essence of practical and targeted to the knowledge of the Nature of the human mind.

[1)] **I beg your pardon for my not very good English!** The original text on Russian**:** http://vixra.org/pdf/1804.0285v2.pdf

[2)] Ontologization is a philosophical generalization. As a result of ontologization phenomenon or entity receive metaphysical status. Here the term "ontologization" is used not in the General philosophical sense, but only in the physical sense. Therefore, in the future we will omit the quotation marks when using this term

[3)] The word "hierarchical" we deliberately took in quotation marks, because of the conditionality of its use is evidenced by the known facts: the results of experiments of A. Aspect detect the direct connection of the microlevel with the megalevel, bypassing the macro-; the possibility of the appearance of singularities in the solutions of the Hilbert-Einstein equations, linking the megalevel to the microlevel, again, bypassing the macro level. Thus, the relationship of *micro-* and *mega-* can have immediate, breaking the hierarchy of subordination.

Epistemological aspects of the third level
(aspects of knowledge representation)

First. The physical reflection of reality in terms of the philosophical concept of activity is the projection of *micro*-and *mega*- into *macro* -.

Second. At each hierarchical level, the causative fragments are characterized by their features, which are described in their own language, taking into account the level of ontologization and within their conceptual framework.

Hint. With the terms "2" and "one and a half" (1.5) it is possible to very compactly express the concept of "3": *"3" - it is "one and a half", taken twice*. Let's denote such vocabulary as *language 1*. However, with the term "3" we will not be able to define the term " 2 " in a finite and complete way as the infinite fraction is 0.6666... With help a finite set of words there this is is not reproducible. This vocabulary is denoted as *language 2*. We see that for the expression of the term "2" in language 2 requires the introduction of some new concepts. However, there is no guarantee that we will not have the next nuances due to the emergence of these new concepts. Thus, the expressibility or *hatchability* of concepts in one language may well be incompatible with the expressibility or hatchability of the same concepts in another language. A similar formulation of problems of hatchability there is in a mathematics: in formal logical systems they represented, for example, theorems of hatchability (Tarski, Gödel}

Thus, it becomes clear that to speak in the language of *macro*-, for example, about the age of the Universe, as a characteristic of megaobject will have a long, uncertain and most likely unproductive.

A similar situation occurs with languages of description at all three hierarchical levels. With a certain degree of freedom, it can be said that some "truths" of one hierarchical level are not "infallible" or simply "incomprehensible" at another level. A striking example of this is the question of the age of the Universe: in the language of macrophysics, we ask a question to the object, which is not yet identified in the causal order of existence. A similar question on the meaning of his understanding for microphysics: What is the dimension of space? These are the questions along with others have a certain meaning only for macrophysics.

Third. It obviously need to create a certain metalanguage common to all hierarchical levels, and the means of converting or translating description languages from one hierarchical level to another. Of course, the expressiveness of the meta-language will be much poorer (in terms of specifics) of the language of a particular hierarchical level. However, ontologization of physical concepts of each level and their conclusion to the meta level of understanding is a necessity to overcome today's crisis in physics. Today the role of meta-language representation of General knowledge plays the language of philosophical generalizations.

The keyword *"exists".* Under the term of *"exists"* there is to be understood the result of ontologization of the attitude of consciousness to the all-embracing Being. This attitude emerges as a reflection of a fragment of material existence in the mind. The attitude of being to consciousness or consciousness to being is the subject of the main question of philosophy, which in materialism is solved unambiguously: *matter is primary, consciousness is secondary.*

The fact of existence is recorded by consciousness either directly through our senses, or indirectly through a special tools designed for this purpose. The intermediary between the fixation of the fact of existence of the fragment of existence and its reflection in the mind are the relevant theories.

To prove the fact of existence is possible only in an empirical way. According to the inductive logic, the opposite is not true: it is impossible to prove the fact of non-existence. An important methodological aspect: we can only talk about existing things, because talking about non - existent is like using zero in arithmetic: so that we do not multiply by zero, the result will always be one - zero!

The possibilities of ontological space-time relations

Let us consider the possibilities of giving the space-time relations the philosophical status of universality of being.

The first thing to note. It was shown above that spatiotemporal relations arise from the factorization of universal existence on existence and co-existence of a plurality of separable and distinct entities. This clearly shows that *the Universe as a whole exists beyond space-time aspects*. Therefore, there is no point in talking about its origin or its end, and there is no point in endowing the Universe any size or shape. The same can be said in other words, using the concepts of eternity and infinity as " figures of speech": *the Universe is eternal and infinite in all its manifestations*. Therefore, in this ontological level formulation of the problems with" initial conditions " can not be correct. **This is the first "stone" in the ontological model of space-time relations, which leaves us when considering the Universe as an object at the zero level of ontologization.**

The concept of space-time relations originates in classical physics, which is known to represent a macrolevel description of physical phenomena. Here the spatial relations are separated from the temporal ones: the three-dimensional spatial manifold connects to the one-dimensional temporal, forming a four-dimensional cartesian's product. Topological association the spatial and temporal relations described using the well-known formula: $d\vec{\boldsymbol{r}} = \vec{\boldsymbol{v}}dt$. For a resulting four-dimensional manifold is used general the point metric classical topology(*PMC-topology*). The possibility of introduction of *PMC-topology* is based on the assumption of infinite divisibility of space-time relations, that is, on the possibility of representation of separable and distinct entities by a 0-dimensional spatial points and moments of time. Time intervals and lengths of formalizing the closeness of the points - physically measurable with the help of independent standards of length and time and therefore can be comparable in their values. This is the essence of the *PMC-topology* of the cartesian product of a three-dimensional spatial manifold and a one-dimensional time manifold, which is based on the euclidean metric at the macrolevel for both three-dimensional spatial and one-dimensional temporal manifolds. The possibility of its introduction is based on the approximation of problems with characteristic lengths and intervals significantly exceeding the atomic ones. In our classification **classical physics would correspond to the third level of "ontologization", i.e. of macrohypostasis.**

Is it possible to continue *PMC- topology* to other hierarchical levels? How do change space-time macrorepresentations during the transition to fragments of universal being in adjacent hypostases *micro-* and *mega-*? What should take place in the dynamic equations of quantum mechanics and GTR instead *r* and *t*?

We can expect that in the quantum theory it will be statistically averaged combinations of the eigenvalues of the operators of the dynamical algebra, which will asymptotically pass into the macroparameters of classical physics. The averaging procedure should be accompanied by the emergence effect of the "condensation" of the hilbert representation into the spatial three-dimension and the manifestation of the possibility of representation (approximation) of macrorelations using point localization described in the framework of the three-dimensional *PMC- topology* [4]. However, it is known that the propagation of the asymptotics to megascales disappears a separate metricity physical lengths and time intervals . It remains only their coordinate affinity (a linear ordering of the coordinates of the events).

The question of questions: *What can we say about space-time topology in the quantum world and how it differs from PMC-topology?*

First. First of all, it is necessary to solve the problem itself of applicability of PMC- topology. It is clear that the use of classical PMC-topology in quantum mechanics leads to well-known paradoxes, since there are no objects of microlevel that do not have classical metric sizes (moment of time, material

point), for point topological images. This paradox is canonized by the uncertainty relations between the particle momentum and its position, between the energy and the time of its measurement and other canonically conjugate variables. Moreover, the phenomena of contextuality of particles, entanglement and nonlocality have already been confirmed experimentally and have become part of the physical reality. It seems to us that it is promising here to replace the scalar classical euclidean measure with probabilistic operator measures (*POM*). At present, the scalar probabilistic measure is used in quantum mechanics. For example, to the question: *what distance is expected between the particle emission event (in one place) and its absorption in another?* - the answer will be: with probability P this distance will be equal to *L*, and the result of the solution will be given in the form of a scalar probability distribution *P(L).*

Second. In connection with the application of the principle of identity of particles there is a nontrivial paradox associated with the distinction of particles. After all, what happens is that due to this principle, we cannot calculate the number of particles. This is clearly because the wave function for a group of particles in this case is one, that is, it describes a single quantum object. That's probably why we can't count the number of particles of the same ensemble. It is impossible to exclude the conclusion that this is one object located in several places at once. And again, this is "stone" into PMC-topology as of the measure of the description of the proximity of particles. It simply ceases to work. The topology of the proximity of the discernible particles reveals oddities and in connection with the known EPR paradox or the results of Aspect's experiments.

Third. One of the main topological parameters is dimension parameter for space. For a macroscopic it is chosen , equal to three. But within the framework of the quantum theory, the value of the dimension of configuration space is not regulated.

Thus, generalization and dissemination of spatio-temporal relations for the task of quantum theory is possible only on the second level of ontologization.

At the megalevel, it is possible to preserve the spatiotemporal *PMC- topology*. However, there is also a departure from the physically traditional topology. Two formally independent spaces: three-dimensional and one-dimensional with ruclidean topologies, are replaced by one four-dimensional with a pseudo-euclidean metric topology (STR). Points, as topology objects, already exist in a single four-dimensional space. The possibility of comparing the lengths of the three-dimensional space and the time intervals of the one-dimensional space by their values is lost, since only the property of affine ordering remains. It is this property and have coordinate values of spatial-temporal events. Furthermore, singularities appear in solutions of the Hilbert-Einstein equations in RTG, which testifies to the limited applicability of *PMC--topology* here.

PMC-topology is used to describe space-time relations at *macro-* and *mega-* physical levels. In the first case euclidean length and time interval are used as proximity measure of separate spatial and temporal relations. Modification of euclidean topology (3+1)-space obtained by cartesian product of three-dimensional space and one-dimensional time, leads us to the pseudo-euclidean topology of a single four-dimensional space-time, in which the *PMC- topology* is constructed in this case. The fact is that of the homogeneity, the isotropy and the inertial symmetry of space-time relations should be an unambiguous conclusion about the existence of a maximum speed of movement of the physical body and propagation of signals. By choosing as a reference the value of the speed of this signal, along with the classical method of measuring the speed using independent standards of length and time, there is an alternative possibility of measuring directly in the units of the speed of the standard signal. The advantage of this standard over the classic (length and time), it becomes obvious when solving problems of transformation of kinematic characteristics in connection with the change of reference systems [4)].

[4)] However in a physical-"metric" topological sense of the relation $d\vec{r} = \vec{v}dt$ in accordance with the standards of length and time is lost..

Thus, the use of PMC-topology is possible at the third level of ontologization: for macrophysical problems it will be physically 3-measurable spatial point topology and 1-measurable temporal point topology. For megaphysical problems, this will be a physically 4-dimensional point topology.

Summary

1. Universe as an object exists out space-time aspect. For it, we will determine the zero level of ontology, and the language of description is the language of philosophical categories.

2. The space-time certainty for the microlevel organization of matter encounters uncertainty in the topology of these relations. Here the level of ontologization should be the second. Nevertheless, today the language of quantum theory of the third level of ontologization is used.

3. The classical description of physical phenomena at the macrolevel is the most complete for the space-time relations, which allows the possibility of physical measurability and numerical comparison of the results: the third level of ontologization, the language of classical macrophysics.

4. In connection with the change of measurement standards spatial-temporal relations at megalevel of organization of matter (near the speed of light and for long distances) it is lost physical measurability of spatial and temporal relations separately. The causality of the description is preserved for events being inside the local light cone.Generalization of the same (3+1)-*PMC-topology* to the topology of four-dimensional space-time allows us to remain at the third level of ontologization. Language of description of the megaphenomena is the language CTR in a more general case - the language of GTR. However, the occurrence of singularities in solutions of the Hilbert-Einstein equations brings us back to the problems of space-time relations in the microcosm.

At the third level of ontologization, in the *macro*- and *mega*- hypostases of the organization of matter it is possible ontologization of spatiotemporal relations, characterized by the affinity (a linear ordering).

The emergence of spatio-temporal certainty

The process of formation of space-time certainty in Leibniz's aspect is modeled on a simple example: the transition from the quantum microlevel to the macrolevel of classical mechanics. In this regard, it is possible to talk about the two-phase existence of matter.

General considerations (the need to raise the issue)

To date, it is already enough arguments to talk about new realities in physics. First of all, it should be noted:

I. It is the sFWT theorem which practically rejects the functional dependence between cause and effect in the traditional topology of space and time. The main result of the theorem is the conclusion that the nearest space-time environment in the classical topology of proximity does not affect the deterministic behavior of the"particle" [5)].

For example, the authors [13] consider that

... *"the particle's response (to be pedantic—the universe's response near the particle) is not determined by the entire previous history of the universe"* ... [p.226];

... *"it* [particle's response] *is not a function of what has happened earlier (with respect to any inertial frame)"* ... [p. 228].

or, finally:

[5)] The term "particle" is quoted because the concept of particle in quantum mechanics is quite contradictory.

... "the FWT suggests to us that determinism is not a viable option".... [p. 230].

They are echoed [14]:

..."Experimenters have free will so their measurement choices are not a function of the past"... [p.8].

..."The conclusion of the free will theorem is that elementary particles have free will in the sense that they produce results that are not a function of the past"... [p.8].

II. After the Aspect, the results of many versions of Wheeler experiments [15] indicate the existence of a correlation between the "particles", the closeness of the connection of which is already determined by the probabilistic measure.

III. As one of the results of these experiments is a statement of the existence of "singles", the speed of which is not regulated by CTR, and experimental confirmation of their existence [16].

IV. The indisputable existence of space-time relations on the macrolevel of organization of matter.

From the comparison I and II, from the experimental confirmation of sFWT and other facts at the microlevel, it follows necessary to replace the topological proximity measure "particles" - from classical (metric) to the probabilistic measure. This follows from the fact that elementary events, as elements of the topology used, have a different nature. And from the IV, that is, from the unconditional evidence of the existence of spatiotemporal relations at the macrolevel, there is a need:

a) to include in the physical agenda the question of emergence of space-time certainty (it is namely - *emergence*, but not inheritance of properties from *micro*- to *macro*-);

(b) to interpretate the causes of the improper use of classical (*macro*-) space-time relationships at the microlevel;

(c) in addition, III raises the issue of spatial resilience of singles and the causes of their degradation at the macrolevel.

The experiments of Aspect and confirmation the results by Wheeler indicate three fundamental conclusionss: no spatial-temporal functional dependency, the "one-particle contextuality" and the "two-particles nonlocality", due to the quantum entanglement.

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i. generally speaking, it is impossible to talk about the properties of smooth of functions with respect to space-time variables, i.e. about their continuity and differentiability;

ii. contextuality leads to incorrect representation of the quantum system as a"point particle". In topological terms, this representation does not correspond to the structureless view it as an element of the space-time topology, which is contrary to fact: in the microcosm there are no prototypes of point of space-time elements;

iii. the third leads to nonlocality of the quantum system as a whole formed by parts.

Thus, a pair of quantum objects as a binary relation can no longer be characterized by point space-time events - they simply do not exist in quantum mechanics. This leads to the conclusion that the space-time relations lose the continuity property in the classical topology. In the result of the *sFWT*-theorem it is clearly states. In this respect, for the algebra of event quantum mechanics, there is a resource the use of probabilistic measure and, in addition, the opportunity to adopt a relational interpretation of quantum mechanics, which explicitly "displays from brackets" of quantum theory the spatial-temporal relations. About this much detail.

There are no point events for classical topology based on the euclidean metric in quantum mechanics. However, it is necessary and possible to collect "aggregates" of such events. For numerical comparison of observations or measurements in these cases, *measures* are used, which allows to evaluate the observed results according to the selected physical standards. In non-quantum physics, the most common and well-known measures are the jordanian [6)] based on the euclidean, pseudo-euclidean, the riemannian, pseudo-riemannian geometries. In quantum physics there is a systematic use of scalar probabilistic and probabilistic operator measures. In such a situation, the "correct" choice of event aggregates for the analysis of experimental data becomes a very urgent task, for the elements of which it is possible to introduce standards suitable for measurement. For the Jordan's measures standards are "images" of lengths, areas, volumes; for probabilistic - "frequencies" or relative frequencies.

On the one hand, *sFWT*-theorem fixes the lack of functional dependence between the cause and consequence related to the *nearest* space-time environment. On the other hand, the results of experiments of Aspect and other authors record the presence of correlations that can influence on reasons and consequences. There is the fact that the topological notion of *proximity* is somehow being modified. We can probably say that the topology on the Jordan's proximity measure changes to the proximity topology on the scalar probability measure for vectors (pure states) and probability-operator measure for density matrices (mixed states). In this case, the description of the cause-effect relationship of events in quantum mechanics is significantly modified. The measurements for probabilistic measures are determined by relative frequencies. With this approach, in particular, the interpretation of the concept of speed in the traditional topology disappears, and at the same time disappears and the contradiction with CTR.

Further, in CTR, relationships between physical objects are formalized using point events. Set of these events are endowed with traditional point geometry and topology based on it. Between any pair of events arise a relationships of proximity, distance, smooth functional dependence with all the methods of mathematical analyze. With the introduction of standards of length and time, arise a physically measurable characteristic of speed as a derivative of distance by time. Finally, the replacement of the standards of length and time on a single standard speed leads to CTR, which is its law of addition of velocities (the lorentz) limits the maximum possible speed of motion of material bodies and the propagation of interactions, signals and disturbances. However, it later turned out that the laws of addition of velocities in classical and relativistic mechanics (due to Galilean's and Lorentz's transformations) are derived independently, based on the topological properties of symmetry and can coexist both - completely independently in the framework of classical physics . At the same time, nonrelativistic physics takes the form of a particular case of relativistic (at low speeds), which allowed to give priority to the relativistic picture of the world and to reach an agreement between classics and relativism. The most important thing about these approaches is that both paintings use a point metric event topology, by which was a priori endowed a spatiotemporal relationships.

However, the choice of a single standard speed to measure space-time relations deprives of the coordinate distances of the invariance, also intervals of time and the velocity in the coordinate representation. An illustration of this can be GTR. Actually, this fact can be considered as an argument for the interpretation of A. Aspect's correlations.

The main feature of the description in the point coordinates of spatial relations in the microcosm is the inability to juxtapose the geometric point (x,y,z) to any object of the microcosm, which does not allow us to talk about the classical topology of spatial relations. Even about the dimension of the space of the microcosm “learns” only through the description and interpretation of macrolevel spatio-temporal dimensions.

[6)] As a generalization of the concepts of length, area, volume...

The ordering time factor t in the Schrödinger's and the Heisenberg's pictures must be understood as *evolutionary* time [7] ; it cannot be called by the *dynamic* time, because at the microlevel there is no possibility of describing the motion of a localized object along the trajectory. Therefore, the attempt to introduce dynamic time, ordered changes in the positions of the localized object on the "background" of other objects becomes contradictory. An evolutionary factor that orders changes in the state vectors or dynamic variables of quantum mechanical systems through solutions to the Schrödinger's and Heisenberg's equations cannot have its own properties of physical measurability. Taking into account fact of physical immeasurable of the state vectors of quantum systems or wave functions, it will be necessary to assign the parameter t the property of affine[8] continuous factor and only in connection with the consideration of the properties of dynamic algebra parameters [3] .

What does the state vector $|\psi\rangle$ describe? Some fragment of reality, which acquires space-time certainty in measurements at the macrolevel: placing the detectors at the macromoment of time t on the point of space with macrocoordinates (x, y, z) we can fix the result with probability $|\langle\psi|\psi\rangle|^2$ as a manifestation of the presence of a quantum mechanical object. Before the measurement, this fragment of quantum reality was a kind of probabilistic virtuality with respect to space-time certainty. Thus, we can say that the subject of quantum physics is the description of the “sea” of probabilistic virtualities, which are observed as reality in the processes of macromeasurements. **It is this virtual background and is the basis of the *pramater*, undifferentiated even in the space-time relation.**

With regard to the physical measurability of temporal relationships at the microlevel, the following should be said.

The measure of the set corresponding to the possible events filling the time interval $[t_1, t_2]$ for the state vector $|\psi\rangle$ of wave function or density matrix will no longer be described as in classical mechanics by the well-known Jordan's measure equal to the value of the interval $t_2 - t_1$. This is because the events themselves occur within the interval $[t_1, t_2]$ of fixed by the initial (t_1) and the final (t_2) points have probabilistic nature and registered of the macrotime way. Probabilistic-scalar or probabilistic-operator measures should be used to describe measures of subsets of such events.

An essential circumstance here is the fact that the topology of space-time relations, based on the Jordan's measure, becomes inapplicable, since the original elements of this topology are 0-dimensional points, and the measure of proximity of points are distances calculated using the Jordan's measure: in quantum physics there are no objects corresponding of 0 – dimensional points or of point space-time events. In the quantum description, there is no possibility of the introduction of microstandard of length, time and speed. It is their absence that is implied when it is said that the physical measurability of space-time characteristics at the microlevel is impossible. Moreover, the most important argument here is the mathematical proof of the limitation, up to the absence, of the functional connection between the perturbation and the response, which is equivalent to the absence of the influence of the past on the future and of the immediate environment on the quantum object [13]. Due to this circumstances, when a quantum description of space-time relations we can speak only about the properties of the affinity order established by *macro*- and nothing more.

Thus, in quantum mechanics time can be considered only as an affine factor of system, ordering by means of *macro*-. The metric properties of quantum-mechanical time are also determined by macrolevel measurement procedures using macrodevices. However, the proof *sFWT*-theorem complicates the direct use of the methodology of this opportunity.

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[7]) Dynamic time refers to the time factor, which orders the geometric position of the point on the trajectory of motion; evolutionary time orders the state of the system. The need to distinguish them is obvious (see[5] for details).
[8]) Means not metric, but continuous.

The formalization of microscopic procedures for spatial measurements determines, among other things, the concept of macroscopic continuous, metrizable and three-dimensional certainty of the spatial existence of a quantum object. The dimension of the configuration space at the microlevel when applying the *irreducibility theorem* is not regulated by any prohibitions.

As known, there is no real movement in the microlevel, as of the movement of a localized object in continuous space. However, we can talk about the virtual motion of the "cloud of probability "when fixing the spatiotemporal relations, that is, when observing the "movement" of quantum objects by classical means of observation at the macrolevel. One must need associate this procedure with the projection of microchanges on the spatial and temporal relationship of the macrocosm.

The fundamental properties of the macrolevel of organization of matter such as continuity and (3 + 1)-dimension space-time are introduced onto the microlevel virtually by definition, according to the solutions of the equations of Schrodinger and Heisenberg and in connection with the need to harmonize *micro*- with the observed properties of the macrolevel behavior. The compromise in the contradictory nature of the General (*micro*- and *macro*-) spatiotemporal relations is achieved by means of a quasi-classical procedure for establishing the correspondence between the quantum and classical methods of a two-level description of physical phenomena (quasi-classical approximation).

The inconsistency of the spatio-temporal relations of the microcosm lies in the seeming *inheritance* of a macrolevel description of these relations from the microlevel. One must say about the *occurrence* of spatial-temporal relations. Based on the irreducibility theorem, here, it is necessary conceptually describe the mechanism of the "*3-condensation*" from *n*-dimensional of a microlevel into the three-dimensional macrolevel description and the mechanism of *localization* in the transition to a three-dimensional macrodescription.

In fact, in this case, we need to build a two-level description of the physical reality and solve the problem of converting one form of description to another. A similar method of representation is used in the description of complex systems for which the random nature of changes in the parameters describing the system at the lower level of *evolution* is combined with its highly deterministic behavior at the upper level of *observation*. At the same time, the evolution of the physical system is determined by its behavior at the microlevel, that is, the change of microparameters, and the observation of the system, that is, the fixation and registration of the observed values, is carried out at the macrolevel.

The transition from a microlevel description of the evolution of the system to a macrolevel observation should be similar to the transition to the manner of transformation of the description of a multiparticle chaotic ensemble of Gibbs with many numbers of microparameters into a description, for example, of a gas enclosed in a certain volume with temperature, pressure, heat capacity, that is, with very limited number of macroparameters. The very same current situation of the search for the essence of space-time relations resembles the early history of the search for the essence of "flogiston", which was resolved by the statistical theory of Gibbs ensembles and the fixation of the concept of temperature as the average of the kinetic energy of the ensemble. It is quite possible that the spatiotemporal relations are also an average of the eigenvalues of the quantum object operators.

The phenomenon of 3-dimensional *(spatial "3-condensation")*

For clarity, we will consider the model of the *Big Bang*, when in the first moments after the explosion, according to the *Grand Unified Theory*, the Universe was dominated by "primary cosmic broth" – a kind of undifferentiated timeless and non-spatial unity of energy, pramateria and all real. Modern science allows us to talk about the eleventh "broth".

In later moments begins and continues effective differentiation "primary cosmic broth" in quantitative and qualitative terms: the matter as the quantity and energy as quality of matter. Arise praelementary, then the elementary "particles", nucleus, atoms, molecules, planets, etc. - other of galactic

and metagalactic structure. In the process, the World is organized in existence and coexistence: the certainty of temporal and spatial relationships arises. "ontological slices " of this phenomenon are detailed in [6]. One of the fragments of the existence of the Universe acquires the features of a macroworld, existing in a 4-dimensional manifold – three-dimensional space and one-dimensional time. The resulting fragment, or 4-manifold has proved to be so stable that exists to this day – we live in it. It is easy to see that here it is possible to talk and about many of these fragments, introducing ourselves the 4-branes.

Let's focus on the uniqueness of the phenomenon of the spatial three-dimension. The fact remains of a real fact that the three-dimensional fragment of general existence is stable in its own existence and coexistence of its parts, which leads to the possibility of localization objects that can not only change and evolve as integrity (obvious and fundamental property of matter), but also to be described in the framework of the current rational paradigms.

The modern physical paradigm connects the association of interactions (physical fields) into a more universal interaction with the increase in the dimension of the space in which the more fundamental elements of matter reside in the united interaction. This process can be considered in the natural order of evolution and of development of physical events after the Big Bang, that is, in the direction of differentiation of universal interaction and its stratification into more substantive and particular interactions. And here we are interested in the final stages-factorization of electromagnetic and gravitational interactions. These fields are basically “glue” the space-time relationship in (3+1)-dimensional entity of being visible to us of the world.

In other words, (3+1)-space-time “condensation” of matter in the process of evolution occurs with the help of gravitational and electromagnetic fields against the background of more universal interactions of the "primary cosmic broth". With this, multidimensional, uncertainty and fluctuations remain in the microcosm, but the determinism and causality relationships in the levels of *macro*- and *mega*- descriptions remain in (3+1)-dimension space-time. Thus, the entire Universe is represented in the form of *two-phase coexistence.*

The mechanism of "condensation" of matter can be illustrated as follows. Some elementary "particles" remain stable as long as they are locked in potential pits, but in the free state they disintegrate in a very short time. Such a locked" particle “turns out to be more macroscopic (that is,” more three-dimensional“, and therefore more stable) than free, which is more microscopic (that is,” more multidimensional", and therefore unstable). Further, atoms, United in molecules, crystal lattices, that is, large collectives, acquire the ability to stable localization in three-dimensional space.

It is here that the possibility of the conceptual wording of the spatiotemporal relations in macrostability and of the ability to manifest the properties of spatial and temporal localization, that is, those properties that are absent in the microcosm, appears.

The question of the relationship 3-dimension of macrospace with the properties of real interactions between the material fragments of the world, apparently, was first staged Immanuel Kant [17]: *... "I suppose: **first**, that to a substances in the existing world, part of which we are the inherent forces of such a kind that, connecting with each other, they spread their action is inversely proportional to the square of their distances; **secondly**, that arising from here a whole has in accordance with this act, the property of three-dimensionality; **third**, that this law is arbitrary and that God could would choose and the other law, such as the law of inverse proportionality to the cube of distances; finally,**fourthly**, that would result from another law and extension with other properties and dimensions.*

And indeed. In classical physics such phenomenon is known: in the gravitational field described by the law of a world gravitation, there are steady closed trajectories. This makes possible the stable existence of planetary systems. This result is easily derived from the 3-dimensional Laplace equations for

$$\varphi \sim 1/r^{n-2}, \qquad (1)$$

the gravitational field potential. In a theory similar to Newton's and describing phenomena in space of different dimension, it is natural to expect that the potential of the field will satisfy the multidimensional Laplace equation. In the space n of measurements the gravitational field potential will be proportional to the value

and the strength of the interaction value

$$F \sim 1/r^{n-1}. \qquad (2)$$

It is with the law of decreasing the potential according to (1) that the main feature of the three-dimensional space marked by (I): the orbits of physical bodies in the newtonian gravitational field in the euclidean three-dimensional space are stable at n ≤3 and unstable at n >3. Ultimately, this means that it is impossible to have a long-term existence of planetary systems around stars in hypothetical spaces with dimensions greater than three. A similar result remains valid in GTR for space-time dimensions greater than 4 (3+1). This follows from the analysis of the equations of geodesic lines on which the planets would move in spherical symmetric fields. The noted features can be attributed to the *macro-* and *mega-* to hypostases of the existence of the world.

However, in the microcosm there are similar mechanisms that distinguish three dimensions as a stable form of existence of matter: only in the space of three (and less) measurements can the stable states of atoms. In the spaces of large dimensions from the Schrödinger equation with a potential of the form (1) follows: either there may not exist (bound states), or negative energy levels extend to a value equal to minus infinity. The latter means that for any energy level there will exist an even lower level and electrons in such systems will fall, emitting energy until their complete disappearance. This means that there is no stable state for the substance.

It is widely believed that namely these circumstances are key to the conclusion that there is no alternative to the three-dimensional reality. However, these facts do not contradict a different conclusion: **the inverse squares law highlights sustainable “condensate” of the existence of matter in three-dimensional macrocosm of our world, and the world itself is essentially at least two-phase forms coexistence matter:“3-condensate ” in the environment less differentiated *pra*matter. "3-condensation “is realized with the direct participation of gravitational and electromagnetic fields, which are the” sum" of more elementary and fundamental interactions.** Such is the general outline of the phenomenon 3-dimension.

Generalizing the above, it could be noted that the Union of interaction fields is accompanied by an increase in the dimension of the physical configuration space - the arena of action of these fields, and the differentiation of the fields and the allocation of individual – reduces the dimension of space, that is, narrows the *topologically* sphere of possible manifestation of its presence. In fact, a peculiar principle of preserving diversity, expressed in the beginning of the last century by the words of the famous classic about the inexhaustibility of the electron, as well as the atom, works. Anyway, the "condensed " matter has a three-dimensional image.

With hindsight we can say that the process of “condensation” of matter to date ended (?) by its three-dimensional localization. Stable three-dimensional formations have survived to the present day in the form of a visible macrocosm, and possibly other virtual worlds. Unstable same multidimensional "designs", however, has not disappeared. They make up the microcosm of the pramatter. They are very strange, probabilistic and uncertain.

Spatio-temporal localization (non-relativistic case)

The microworld objects are described by Hilbert space vectors or wave functions obeying at n=3 in the coordinate representation to the schrödinger equation

$$i\hbar \frac{\partial \Psi}{\partial t} = -\frac{\hbar^2}{2m}\Delta\Psi + U(x,y,z)\Psi. \qquad (3)$$

Following [1, f. 46.1], substitute into the Schrodinger equation the wave function Ψ in the form:

$$\Psi = ae^{iS/\hbar}. \quad (4)$$

As a result, we obtain two equations for the real and imaginary parts:

$$\frac{\partial S}{\partial t} + \frac{1}{2m}(\nabla S)^2 + U - \frac{\hbar^2}{2ma}\Delta a = 0 \quad (5)$$

$$\frac{\partial a}{\partial t} + \frac{a}{2m}\Delta S + \frac{1}{m}\nabla S \nabla a = 0 \quad (6)$$

The first equation (5) up to the terms of the first order by ħ coincides with the classical Hamilton-Jacobi equation for the action S of a particle [19, f. 47.1].

The second equation (6) after multiplying by 2a can be rewritten as

$$\frac{\partial a^2}{\partial t} + \text{div}\left(a^2 \frac{\nabla S}{m}\right) = 0\,, \quad (7)$$

coinciding in form with the continuity equation.

Taking into account the representation (4) and equation (5), we can see that $a^2 = |\psi|^2$ is probability density for those or others coordinates of the quantum object's, and $\nabla S/m = \vec{p}/m$ – associated with the derivatives by time of these coordinates (velocity $\vec{v}$). Equation (7) relates the change probabilities density with the density in the continuity equation, that is, describes the change of coordinates of the virtual cloud of probabilities how the movement of a classical particle with velocity $\vec{v}$.

The first equation (5) of the pair, as consequences of the Schrödinger equation, defines evolution and the connection of quantum numbers as elements of the dynamic algebra [3], including continuous parameters of the irreducible representation q and p of the completeness theorem. Note that this equation does not imply any topological and geometric properties of the parameters q.

It is the second equation (6) in the form (7) of the pair that gives the parameters q and t the classical attributes of the space-time relations. The need of defining initial conditions $q_i(t = 0)$) when solving equation (5) determines the need to set initial point of reference (i.e., reference system) for defining dependencies $q_i(t)$.

The movement of the virtual cloud as an object obeys the laws of classical mechanics. A characteristic feature of this object is its non-localized. However, the General solution of the Schrödinger equation (3) is the superposition of de Broglie waves as Fourier decomposition and if the lengths of these waves and periods are small in comparison with the characteristic macromeasures L and characteristic macroperiods T, then the similar characteristics of the wave packet superposition of these waves will also be small quantities. The movement of such an object will obey the classical Hamilton-Jacobi equation. It is here that the possibility of manifestation of the effect of localization of a quantum object arises and of the opportunity to introduce the concepts of a point, the distance between points and the metric topology of the proximity of points as an approximation. Through the ratio $v_\alpha = dx_\alpha/dt$, the notion of time interval and point of time is introduced. In this way metric relations with point topology are introduced as approximation (quasiclassical approximation) by parameters of dynamic algebra of microobjects.

Thus, through a quasiclassical approximation of quantum mechanics, we come to the notion of a point particle existing and capable of motion in a continuous metric space-time with classical topology.

The main conclusion of this review is the possibility of factorization of the wave equation (3) into two components – algebraic (5) and topological (7). In the relativistic case, however, there is no

topological component for one-particle wave equations. The possibility of a one-part description disappears, and the possibility of a multiparticles description should be considered as an appropriate change in the topology of the microcosm.

It should be noted that non-localized and non-condensed matter can serve as a key to understanding the phenomenon of "dark" matter, the influence of which on the picture of the universe is determined by Λ-term in the Hilbert-Einstein equation.

Q & A

According to results of previous on-line dialogues on the author's seminar a number of questions which require clarification

Explain us by fingers on here all about what's in the article, please.

In short to formulate the topic of discussion we may so : the results evidence the *FWT*-theorem (the lack of influence of the nearest spatial environment and the past history of the behavior of elementary particles) review - what it's meaning? This phenomenal result was confirmed experimentally this year. As a universal disorder m***i***crocosm turns into a spatio-temporal order of the m***a***crocosm? Unfortunately, to understand it in the language of classical physics is impossible.

Are the results of statistical interpretation of Aspect's experiments in favor of this theorem?

Moreover, Wheeler's experiments are reinforcing the Aspect's results. Itself *FWT*-theorem experimentally confirmed separately this year (arXiv:1603.08254v1 [quant-ph] 27 Mar 2016)

By the way, in the same vein, there is an experimental confirmation of the influence of the future on the past (retro causation) , a Simple example is given in the header of the post. This so-called Wheeler's experiments with delayed choice (arXiv: 1407.2930v3 [quant-ph] 19 Mar 2016) .

1. *Let's describe more clarification, what it is " universum of probability virtuality"?*
2. *"..when a virtual(micro-) becomes real (observable)"?*

1. The entire phrase in the text is in quotation marks - and it is made for short, just so. Full disclosure is the entire volume of the quantum theory and latest results on the links to author's works. More fully: quantum objects are the objects with their relations and processes, measured by using scalar and operator of probability measures. The measurements turns the virtual (*micro-*) into the real observed (macro-).

2. Virtuality in physics has a meaning of the probability or possibility. Spectra of possible outcomes are presented by elementary events which might to become real. The virtuality becomes reality, in the sense of certainty of choice of possible in the processes of measurement. All of these processes are described in the standard "ideologues" of the quantum theory and probability theory.

Imagine a coin tossing. The coins have a property that can take two values "heads" or "tails". Before the coin toss this property is unknown. However, it may became a manifestation of any the value of this property as the result of the toss. This property is virtual before tossing. The process of throwing implements this property and the property turns into reality as the result of the process. Here you can see that the coin remains a coin and a property acquires its certainty. Materialism is in no way suffering!

More precisely. Quantum objects are described by vectors and operators in the Hilbert space, which have their own characteristics. As in the previous example, they are in a state of initial uncertainty. However, the spectra of these values are known in advance and all states are possible (virtual). The measurement procedure of any of the values give its the certainty, turning values into reality. It is in the process of measurement of a virtual state turn into a real.

By virtual background you need to understand something of the formless uncertainty of the values of the characteristics of objects, undifferentiated even in the space-time relations. However, here the characteristics, it is one quality, objects - another, in full accordance with the principles of materialism. The only certainty here is the unity of all things without answering the questions: *what, where, when and how much?* It is this essence and is a primary "mess" of the ***primal substance***, which is named here as " universum of probability virtuality ".

Dualism, locality, determinism, causality

1. Dualism as a conceptual idea is a term that emerged at the dawn arising of quantum mechanics when some have been trying to interpret the quantum mechanics by techniques of classical physics. In fact, quantum objects are not wave and not particles. It is a completely different entity that manifests at the macrolevel properties of "particles" and "waves". This gives you the opportunity to work with these properties of the quantum objects. See here for more details: arXiv: 1407.2930v3 [quant-ph] 19 Mar 2016 .

2. In the article we are not talking about the **arising** of space-time (World) or the **disappearance** of causality. We are talking about the emergence of the *definiteness* of the space-time relations, the reshaping *form* of causality. The essence of materialism indestructible!

In addition, it is necessary to speak in detail and in fact, since the *FWT*-theorem has already been proved and confirmed experimentally. For the same philosophy it was allowed generalizations based only on physics.

The problems of the existence of spatial-temporal relationships in the physics is already set up (up to their "retirement").

In general, the paradigm of cartesian causality in physics is based on spatial-temporal relationships in the form of functional relations. However, *FWT*-theorem rejects the functional relationship between cause and effect in a traditional topology of space and time. ***FWT-theorem says the namely so.***

3. To clarify these issues, one must use words of next works:

⇒ John H. Conway and Simon Kochen. *The Strong Free Will Theorem.* Notices of the AMS Volume 56, Number 2 (p.226). https://www.dropbox.com/s/l5varmr5gofwu44/Cohen-rtx090200226p.pdf?dl=0

⇒ Bi-Heng Liu, Xiao-Min Hu, Jiang-Shan Chen... *Experimental test of the Free Will Theorem.* arXiv: 1603.08254v1[quant-ph] 27 Mar 2016. (p.). https://www.dropbox.com/s/zf4n5c53jya66bt/1603.08254v1.pdf?dl=0

And before reasoning about the posed problems it is necessary to give a precise definitions of *locality*, *determinism* and *causality*. After all, about those properties and says (negatively) FTP-theorem. It is the fact that common words (even in philosophical categories) is not enough to understand about what was talking on in FWT- theorem (Conway and Kochen) because it leads to wrong conclusions, for example, to such ... *determinism, as a principle can't to be broken due to causality*... But they in fact proved the opposite. I explain.

Locality - a topological closeness on the language of continuity.
Determinism in physics is concretized in the concept of functional dependence.
Causality in physics - a functional dependence on the immediate environment and the past (defined topologically).

Thus, *locality, determinism, causality* in physics is concretized in the concept of a rather smooth functional dependence.
The proof of the lack of such a functional dependency is "stunning" result obtained by Convay and Kochen, confirmed experimentally this year alone. This is a new physical reality!

4. In fact, the causality in this case does not disappear, it changes form, turning from the traditional functional forms in the shape of a triad of Darwin. A similar example for mnemonics gives the evaluation of the integral of a smooth function (continuous and having derivatives) non-analytic method Monte-Carlo. However, this example provides an opportunity to understand how the probability measure of the set of point events can be approximate to Jordan's measure. The details in the articles.

It is important to understand the need to move from Jordan's measures to the measures of the probability-operator measures, or other, i.e. from the classical methods of mathematical analysis to the methods of group theory (symmetries) and some super selection rules, i.e. from the deterministic description of evolution (in the form of differential equations) to the description with help of the " Darwin's triad".

Why phases is and why topological?

This is probably the main question one which that I would like to hear and get some hint of ideas and associations on this subject. Once again about it here.

1. sFWT-theorem denies the functional dependence between the spatio-temporal surroundings and the quantum object under measurement that is confirmed by experimental data. But namely that functional relationship in physics expresses the principle of causality in classical physics (macrolevel). Thus, the results of Conway and Kochen deny classical causality.

2. There is no doubt about the existence of causality in the macrocosm. However, causality in the microcosm in the classical sense is absent. That is, the World exists, at least in two hypostasises - "causal" and " causeless". The causal hypostasis immersed in the space-time relationship. But there are not such relations in causeless hypostasis. Hence it arises the need to consider the existence of a two-phase "filling" of the World.

3. Given the spatial-temporal understanding of causality in *macro-*, there is a need to explain the emergence of spatio-temporal definiteness of the macroscopic world from *micro-*.

4. The macrocosm has (3+1) dimension, the dimension of the microcosm is not regulated by anything. In these conditions, an obvious it's is need difference of topological approaches is formed. In addition, the concept of the space-time "closeness", continuity, differentiability – all of these characteristics relate to the subject of topology.

5. The article offers a visual (and therefore greatly simplified) the mechanism of occurrence of spatial-temporal certainty of *macro-* and *mega-*.

6. Philosophical questions on this topic stated in the work : [6].

What difference between the measurement from observation?

The first. The difference between the measurement and observation can be understood on the example of the two-slit experiment *). In difference of measurement (active impact of on the quantum object), observation is a passive operation.

So for example, if on the screen we see a trace of intensity from bell-curve, we conclude that a quantum "particle" passed through one of the slits, i.e. the quantum object showed particle properties. But it is important to understand that it is impossible to talk about the trajectory of the photon, and especially through which of the slit he went **). If the screen shows an interference pattern, we conclude that the quantum object showed wave properties. That is, in this episode we just see - in some hypostasis before us appeared a quantum object is it a wave or particle.

With the help of active operations of measurement, hypostasis of object can be changed. And changing wave-particle hypostasis is to initialization of the *single*, which speed in here is not regulated by STR.

The second. How do happens the interaction and impacts of photons on each other during the measurements? The significant addition here is the fact that there are one-particle and two-partial interference. So launching one photon towards of the two slits, we get situation of entanglement actually lead to the manifestation of wave hypostasis **). Therefore it is not necessary "to invent" mechanisms of interaction of photons in two- and multiphoton experiments. **Photons as particles do not interact with each other in the classical sense.** Quantum object interacts with the measuring devices, and during observation (by using any of the detectors) display its properties, including wave-particle. From what and how the observed - we will see the different pictures. Such is the nature of the world of microobjects!

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*) It should be noted that the slit experiments are used for illustration only. They were replaced by interferention-laser experiments, which is much more practical and are modeled using quantum computing. Recent experiments to detect gravitational waves belong to this class of experiments.

**) A good illustration of the manifestation of such properties is given in a popular article by Igor Ivanov about the smile of the Cheshire cat

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But the distinction of a shape of the curve on the screen is also an active dimension with using the eyes with their "rod cells" and "cones". In addition, the consciousness of the experimenter must be present.That is, the consciousness of a thinking subject is included in the quantum measurement procedure, and the process itself acquires the quality of subjectivity.Thus, passive measurement is, in fact, the process of understanding? Popov M. A. (In defense of quantum idealism. UFN, 173, No. 12, December 2003).

About "idealism" in quantum mechanics is not worth it... Russia - even though the former, but and now physical strength!
In a general case, the dimension should be seen as a process of obtaining objective certainty about the condition. In this respect, it is important to distinguish *selective* and *nonselective* measurements. For this reason is well explained by F. A. Kaempffer (*Concepts in quantum mechanics.* Academic Press. New York and London, 1965). However, subtleties are not "in here".

In simple form and on fingers it looks like this: it is measurement procedure, for example, in the two-slit experiment is the measurement of the process from the occurrence of a photon to absorption it, and absorption that is the final stage of the objective process. In this process may be intervened by some disturbance that will bring certainty to a dichotomous variable taking only two values (wave | particle). Then it is this measurement is selective (with choice) measurement. Just this fact allows to talk about retrocausation and about the possibility of the operation of quantum erasure. If in the process of dissemination does not interfere with the disturbance, this measurement will be a non-selective measurement.

There are situations when we can with certainty predict the result of the experiment, for example, not interfering in the course of the experiment. Here with 100% certainty we can predict that our dichotomous variable will take the value of "wave". There is no need to introduce "the mind of the holy spirit"!

Well, and so on for this reason ...

Literature for further "immersion":

⇒ J. Schwinger. *The algebra of microscopic measurement.* Proc.N.A.S. US 45,1542 (1959)

⇒ F. Kaempfer. *Consepts in quantum mechanics.* World. M., 1967

Kasimov V.A. *And it is necessary many-worlds interpretation of quantum mechanics?* Novosibirsk. 2013 г. [18].

"...a statement of the existence of a "singles", which is not regulated by one STR... " . If you can - tell more about the singles and their propagation.

A quantum object can exhibit its properties as waves of, so and particles. In the quasi-classical interpretation this phenomenon is interpreted as a manifestation of corpuscular-wave dualism. A quantum object has a completely different material nature. Known methods of classical physics are applied to the description of these objects, considering a quantum entity as a wave or particle, ignoring the fact that it is a single entity and should be considered as a whole, that is, as the integrity of the object and its properties.

Change "image" (wave or particle) is derived for the entire object that possesses the property of integrity. The very same "action" happens at the moments of measurement (active operations), which is considered as the initiation of *single*. Object, considered as a wave is not localized spatially. Therefore, the mechanism of transformation of one incarnation (the wave) to another (particle) or vice versa, in the space-time relation cannot be described as a point or wave designs, as a "half-hearted" .

A good example is giving consideration to the paradox with the absolutely rigid and absolutely weightless rod (i.e., perfectly rigid and massless). Shift one end of the rod leads to a momentary shift of the other end. The speed of propagation of this perturbation is equal to infinity! Here the integrity of an object (rod) is guaranteed to conceptual rigidity. In the case of the quantum object "stiffness" is guaranteed by conceptual integrity of the quantum object.

The existence of the *singles* confirmed experimentally. Regarding the speed of their distribution there is no consensus. However, in some experiments fixed superluminal speeds.

Obviously, the *singles* are not the signals, since their distribution is not related to the transfer of energy from one point to another. That is why the speed of *singles* is not regulated by STO.

On Λ-member ??? It should be noted that non-localized and non-condensed matter is the key to understanding of the phenomenon of "dark" matter, whose affect on the picture of the universe is determined through Λ-term in the equation of the Hilbert-Einstein.

(3+1)-localization and condensation allows to speak about the two-phase model of matter existence. Separation of variables in equation (3) using (4) factorizes the situation in the classical fragment - localized, deterministic, incoherent (the equation of Hamilton-Jacobi (5)) and in the quantum fragment - non-localizable, non-deterministic, but coherent (7).

The equation of Einstein-Hilbert in the form:

$$R^i_k - \frac{1}{2}\delta^i_k R = \varkappa T^i_k - \Lambda\delta^i_k,$$

also factorizes the situation (right part of the equation) to the energy-material part (T^i_k) and "mysterious" part (Λ). The connection of the quantum approach (*micro*-) and the cosmological approach (*mega*-), perhaps through *macro*-, will necessarily find its methodological perspective, which will be embodied in the properties of Λ-member, affecting the properties of the global space-time relations (R^i_k).

In connection with the discussion on quantum decoherence I decided to appeal to the origins debate on the two-phase matter (https://my.mail.ru/community/physiks.princips/5F7F98A2C08D8300.html). Can we consider the quantum decoherence and relaxation as a couple of the mechanisms of condensation and localization in a two-phase model of matter of a dynamic equilibrium of phases?

Yes, it is already a couple years of the history of the issue (at a seminar):
:https://my.mail.ru/community/physiks.princips/7741D519463C294E.html
https://my.mail.ru/community/physiks.princips/07818B1284324DD0.html

The parallels are certainly there. But, here, about "the mechanism" – I doubt it ... Of course, the question is interesting, but the answer is not yet the time... Today it is only in stage of possible interpretation or choice of language suitable for interpretation...

About the parallels.

I.

1. The use of the correspondence principle [3] as a methodological guide for solving the problems of QM⇔CM transition allows to realize the description of transitions from the vector picture of Hilbert's space to the picture of the phase space "*back and forth*" using the hamiltonian formalism.

2. From equation (5) in [9], the kinematics of quantum "particles" can be represented as the motion of "probabilistic cloud" according to equation of Hamilton-Jacobi [19]. The action as a function of *coordinates* and *time* should be the phase of the wave function.

3. The evolution of "cloud of probability" obeys the continuity equation (7) in [9]. This fact confirms the possibility of using the statistical matrix, which in quantum mechanics appears to be hermitian operator, called the density matrix [20] .
The evolution of the density matrix obeys the Liouville's equation associated to a commutator or Poisson bracket with a Hamiltonian of the system.

4. The transition to quasiclassics, e.g. in the approximation the WKB (Wenzel, Kramer, Brillouin), complete the traditional procedure of transition from QM ⇔ CM.

The scheme (1-4) allows to understand, if not the mechanism, but the essence of the emergence of spatio-temporal certainty. We emphasize once again that we are talking about the classical *certainty* in CM, not of the *entity* itself".

However, by the results of this transition, questions arise, related in content to those which arise in connection with the attempted resolution of the paradox "the cat of Schrödinger ". There is the context of solving the problem of a unified description of quantum theory and classical mechanics in the work of W. Zurek: the disclosure of the concepts of decoherence and relaxation of quantum properties and the possibility of recovery through the use of coherence properties of quantum entanglement [11].

II.
Next. Equation (17) in **[10b]** determines the density matrix with the release of three operators: von Neumann, relaxation and decoherence. Using the transform by Wigner W(x,p) (20) is derived the equation of motion for "W(x,p)-particles" (24). The equation contains three members: liouvillian, friction and decoherence. The equation shows how the classical dynamics in the form of a Liouville follows from quantum dynamics. The last term describes the diffusion in space of the pulses, neutralizing the uncertainty principle. This is the "mechanism" of classical space-time localization upon W. Zurek.

Is it not remind the transition from the description of coherent states to describe decoherent states – the well known process of transition from the many particles description to Maxwell's description in molecular physics and then to macro- and at last to the thermodynamic description?

If we talk about the emergence of the concepts of temperature, volume, pressure etc. from the Maxwell's distribution and their measurements at the macrolevel, then the situation looks quite similar. However, the entities of objects, are described by different theories: in the first case it are a classic objects (particles), in the the second – quantum that are not particles. There are not particles in quantum mechanics, they can't exist as a certain something, to move, to "fly", etc. The object of the microcosm is a completely different entity - it is quantum, it is not reducible to the classics.

And in the two-phase model of matter the mechanism of decoherence can be viewed as a kind of "condensation" and "crystallization" of the primary matter into "dense" bodies of the macrocosm, can't it?

In general terms, it is...

The transition from the microlevel's description of the evolution of the system to the macrolevel, should be similar to the transition

The transition from the microlevel's description of the evolution of the system to the macrolevel, should be similar to the transition by the manner of the transition from the chaotic many particle's description of the Gibbs ensemble with many number of microparameters, to the description, for example, for the gas enclosed in a particular volume, with temperature, pressure, heat capacity – that is, with a very limited number of macroparameters. Itself the current situation of the search for the essence of spatial-temporal relations is reminiscent of the early history of the search for the meaning of "phlogiston", which was resolved by the statistical theory of Gibbs ensembles and the fixation of the notion of temperature as average kinetic energy in the ensemble. It is possible that spatio-temporal relations are a kind of average values of eigenvalues of some operators of the quantum objects.

In particular, (3 + 1)-space-time “condensation” of matter in evolution occurs in the presence of gravitational and electromagnetic fields on the background of more universal interactions "primary cosmic broth". Here, the multidimensionality, uncertainty and fluctuations remain in the description of the microcosm, and (3+1)-spatial-temporal dimensionality and determinism go to the levels of *macro*- and mega- descriptions. The whole Universe is represented in the form of two-phase coexistence.

The essence of the "condensation" of the substance can be illustrated as follows. Some elementary "particles" remain stable, when they are trapped in some "potential pits", but in free States they disintegrate in a very short time. Such captured "particles" are more macroscopic (i.e.," more 3-dimensional" and therefore more stable) rather than free, but more microscopic (i.e. more "multidimensional" and therefore unstable). In addition, atoms are combined into molecules, crystal lattices, that is, large "commands", and therefore acquire the ability to stable localization in three-dimensional space.

It is here where the possibility of conceptualizing spatio-temporal relations of the macrocosm: the ability to stability that is, to show the properties of the spatial-temporal localization, which is not characteristic of a microcosm. And the result formulated as the existence of a (3+1)-condensate on the background of the "primary cosmic broth" in a state of virtual "sea of probability". The phenomenon of decoherence also allows us to expand and deepen two-phase concept of matter. Description of the elementary model presented in this article.

Apparently, the allocated basis of W. Zurek assumed it as the frame in classical procedure of measurement, that is formation of spatio-temporal macrocharacteristics?

In general, it is this, but with some clarifications. Moreover, the possibility of bringing the density matrix to the jordanian form (to block-diagonal), allows us to hope for the fragmentation of the quantum system with preservation of the phase correlationships between the subsystems describing by the matrix blocks, which is a "transparent" hint to model with the "wave-pilot" de Broglie-Bohm. And in general, the possibility of factorization of the density matrix in a similar way " lies in the plane" of the solution the problem of separation of the coherent quantum system into its component subsystems (if it feasible).

The latter note allows to divide system parameters into controllable, preserving the coherence (entanglement), and uncontrolled (unknown, destroying entanglement). This circumstance gives the opportunity to "raise" the entanglement the small group of the monitored parameters to the *meso*- and macrolevels and, at the same time, to explain the disappearance of coherence in a large group of uncontrolled parameters.

On topological phases of matter
(the formation of the image (3+1) and localization of spatio-temporal relations)

The current situation of the search for the essence of space-time relations resembles the early history of the search for the essence of "phlogiston", which was resolved by the statistical theory of Gibbs ensembles and the definition of thermodynamic concepts and, in particular, the concept of temperature as the average kinetic energy of the ensemble. It is quite possible that the spatiotemporal relations are also an average of the eigenvalues of the quantum object operators.

The transition from the microlevel description of the evolution of the system to a macrolevel observation should be similar the transition in the manner of the description transformation of a chaotic multiparticles Gibbs's ensemble with many microparameters into a description, for example, of a gas enclosed in a certain volume with temperature, pressure, heat capacity-that is, with a very limited number of macroparameters.

The need to raise the question of two-phase matter goes back to the works [6,9].

"Rising" from *micro*- to *macro*- in the description of physical phenomena, it is difficult not to note the peculiar phenomena of "*condensation*" and "*localization*" of matter, not peculiar to the material objects of quantum mechanics.

(3+1) -"condensation"

(3+1)-space-time “condensation” of matter in the process of evolution takes place against the background of gravitational and electromagnetic fields in the environment of more universal interactions of "the general primary bouillon". At the same time, multidimensional, uncertainty and fluctuations remain in the description of the microcosm, and (3+1)-space-time dimension and determinism reach the levels of *macro*- and *mega*- descriptions. The entire universe must then be presented in the form of two-phase coexistence. At the same time, multidimensional, uncertainty and fluctuations remain in the description of the microcosm, and (3+1)−space-time dimension and determinism reach the levels of *macro*- and *mega*- descriptions. The entire Universe must then be presented in the form of *two-phase* coexistence.

And indeed. In classical physics such phenomenon is known: in the gravitational field described by the law of a world gravitation, there are steady closed trajectories. This makes possible the stable existence of planetary systems. This result is easily derived from the 3-dimensional Laplace equations for the gravitational field potential. In a theory similar to Newton's and describing phenomena in space of different dimension, it is natural to expect that the potential of the field will satisfy the multidimensional Laplace equation. In the space of *n* measurements the gravitational field potential will be proportional to the value:

$$\varphi \sim 1/r^{n-2},$$

and the strength of the interaction value:

$$F \sim 1/r^{n-1}.$$

It is with the law of decreasing the potential according to (1) that the main feature of the three-dimensional space, noted by Kant, is related: the orbits of physical bodies in the newtonian gravitational field in the euclidean three-dimensional space are stable at $n \leq 3$ and unstable at $n > 3$. Ultimately, this means that it is impossible to have a long-term existence of planetary systems around stars in hypothetical spaces with dimensions greater than three. A similar result remains valid in GRT for space-time dimensions greater than 4=(3+1). This follows from the analysis of the equations of geodesic lines on which the planets would move in the spherical symmetric fields. The noted features can be attributed to the *macro*- and *mega*- hypostases of the existence of the real world.

In the microcosm there are also similar reasons that distinguish three-dimensional as a stable form of existence of matter: only in the space of three (and less) measurements possible stable existence of atoms. For the spaces of large dimensions from the Schrödinger equation with Coulomb's potential of the form (1) follows: states with negative energy levels (bounded states) or may not exist at all, or negative energy levels extend to a value equal to minus infinity. The latter means that for any energy level there will be exist an even lower level and electrons in such systems will fall, emitting energy until their complete disappearance. This means that there is no stable state for the substance.

It is widely believed that these circumstances are key to the conclusion that there is no alternative to the three-dimensional reality. However, these facts do not contradict a different conclusion: the inverse square law distinguishes sustainable “condensate” of the existence of matter in 3-dimensional macrocosm of our world and the world itself is typical, at least two-phase coexistence: “3-condensate ” among the less differentiated the *pra*matter. "3-condensation “is realized with the direct participation of gravitational and electromagnetic fields, which are the” sum" of more elementary and fundamental interactions. This is the general essence of the phenomenon of 3-dimensional .

On the example of the phenomenon of Kaluza [4] and generalizing the above, it could be noted that the unification of the interaction fields is accompanied by an increase in the dimension of the physical configuration space – the arena of the action of these fields, but a differentiation of fields and the allocation of individual-reduces the dimension of space, that is, narrows *topologically* the sphere of possible manifestation of its presence. In fact, a peculiar principle of preserving diversity, expressed in the beginning of the last century by the words of the famous classic about the inexhaustibility of the electron, as well as the atom, works. Anyway, the "condensed" matter has a 3-dimensional spatial image.

With hindsight we can say that the process of “condensation” of matter to date ended (?) of 3-dimensional object localization.[9)]. Stable three-dimensional formations have " survived "to the present day in the form of visible *macrocosm*, and possibly other "virtual" worlds. In a stable phase of the visible macrocosm co-exist, and we live. Unstable multidimensional constructions, however, did not disappear. They make up the *microcosm* of the prime matter –very strange, probabilistic and uncertain (weakly structured).

Thus, against the background of electromagnetic (matter) and gravitational (space objects) fields, the universe acquires the image of a variety (3+1)-dimension.

(3+1) - "localization"

The causes of localization of the substance can be illustrated as follows. Some elementary "particles"[10)] remain stable as long as they are locked in potential pits, but in the free state they disintegrate in a very short time. Such a locked "particle “turns out to be more microscopic (that is,” more three-dimensional“, and therefore more stable) than free, which is more microscopic (that is,” more multidimensional", and therefore unstable). Further, atoms, united in molecules, crystal lattices – that is, large groups, acquire the ability to stable localization in 3-dimensional space.

It is in this case that arises the possibility of the conceptual formulation of the spatio-temporal relations of the macromere – stability and the ability to manifest the properties of spatial and temporal localization, that is, those properties that are unusual for the microcosm, and the result itself is formulated as the existence of (3+1)-condensate against the background of "virtual sea of probabilities". The phenomenon of decoherence allows us to expand and deepen the two-phase concept of matter. Description of the elementary model is presented in article [9].

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[9]) From the point of view of dynamic evolution of the Universe from some singular beginning (for example, BBT)

[10)] We deliberately quoted the word "particle" because there are no classical particle properties in the quantum mechanics of objects.

Decoherence in the formation of spatio-temporal relations

This question relates to leveling (smoothing) of quantum superposition, entanglement and of the uncertainty principle, in the words of W. Zurek - to formation tight bodies .

Let's consider a quantum "particle", located in the environment of its surroundings. We start discussing the situation with the words W. Zurek [10, p 12]:

... "A tractable model of the environment is afforded by a collection of harmonic oscillators(Feynman and Vernon (1963), Dekker (1981), Caldeira and Leggett (1983, 1985), Joos and Zeh (1985), Paz et al. (1993) or, equivalently, by a quantum field (Unruh and Zurek (1989). If a particle is present, excitations of the field will scatter off the particle. The resulting "ripples" will constitute a record of its position, shape, orientation, and so on, and most important, its instantaneous location and hence its trajectory" ...

... "A boat traveling on a quiet lake or a stone that fell into water will leave such an imprint on the water surface. Our eyesight relies on the perturbation left by the objects on the preexisting state of the electromagnetic field. Hence, it is hardly surprising that an imprint is left whenever two quantum systems interact, even when "nobody is looking," and even when the lake is stormy and full of preexisting waves, and the field is full of excitations—that is, when the environment starts in equilibrium at some finite temperature. "Messy" initial states of the environment make it difficult to decipher the record, but do not preclude its existence" ...

In the two-phase model of matter, decoherence can be considered as a kind of part of the mechanisms of "condensation" and "crystallization" from the primary matter into the tight bodies of macroworld, and the theory of decoherence allows us to talk about the environment (pramatter), characterized by its internal parameters, in which the tight bodies of macroworld are formed.

In the article by W. Zurek [10] provides an equation which resembles the equation of evolution in the Heisenberg picture for the dynamic observed.

The motion equation for "$W(p,x)$ - particles" associated with the environment is presented as:

$$\frac{\partial W}{\partial t} = \underbrace{-\frac{p}{m}\frac{\partial}{\partial x}W + \frac{\partial V}{\partial x}\frac{\partial}{\partial p}W}_{Liouville\ \ Equation} + \underbrace{2\gamma\frac{\partial}{\partial p}pW}_{Friction} + \underbrace{D\frac{\partial^2 W}{\partial p^2}}_{Decoherence},$$

and the equation itself can be obtained from the expression for the density matrix $\rho(x,x')$:

$$\dot{\rho} = \overbrace{\underbrace{-\frac{i}{\hbar}[H,\rho]}_{\dot{p}=-FORCE=\nabla V}}^{Von\ \ Neumann\ \ Equation} - \overbrace{\underbrace{\gamma(x-x')\left(\frac{\partial}{\partial x}-\frac{\partial}{\partial x'}\right)\rho}_{\dot{p}=-\gamma p}}^{Relaxation} - \overbrace{\underbrace{\frac{2m\gamma k_B T}{\hbar^2}(x-x')^2\rho}_{Classical\ \ Phase\ \ Space}}^{Decoherence}$$

However, can the description of the decoherence mechanism by W. Zurek be considered exhaustive to describe the transition from quantum theory to classical mechanics?

In the last expression, the derivative by time is present as an algebraic operation (commutator $[H,p]$), but it also contains the expression $\frac{i}{\hbar}\frac{\partial}{\partial x}$, which is the momentum operator, but not in an algebraic form – in the coordinate representation and is in point topology; in addition, there is also the operator of coordinates in the momentum representation $\partial/\partial p$. Mathematics of δ-function was applied for this purpose. However, the mathematical analysis does not accept it in the "dress code" of traditional continuity. This determines the degree of generality of the reasoning of W. Zurek in part of the transition from quantum mechanics to classical. **There are no point features in quantum mechanics**. Thus, an important moment of realization of the possibility of transition from Hilbert's space into phase space on

the basis of real (3+1)-macrospace of classical physics and conceptual description of this transition using the *principle of correspondence* [3] – cannot be considered complete. It is quite natural that these two phases of matter should be described not only by different concepts, but also by different topologies (for example, they differ in their most important characteristic - dimension). In this respect, it should be noted that the application of the *principle of correspondence* in the transition from quantum formulations to formulations in Hamiltonian formalism requires a priori introduction (3+1)-the classical image of the space-time relations directly into quantum mechanics (coordinate representation).

However, answers to the localization processes associated with spatio-temporal splitting of coherent quantum objects and their fragmentation into tight and independent component parts can be obtained in part explain the mechanisms of decoherence of W. Zurek

The essence of his idea is the following: the General phase of the composite system between the components included in the initial superposition of States "W(p, x)-particles" dissipate in degrees of freedom of the environment, reducing and eliminating interference and, thereby, diagonalizing the density matrix, which then can represent a mixture of States with classical probabilities without interference terms. This eliminates the quantum superposition and entanglement of States. The increase in the size of the elementary cell of the phase space of the system leads to the possibility to neglect the uncertainty of Heisenberg and pass through the quasi-classical to the classical description of the systems.

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Для связи:
quadrica-m@mail.ru

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http://orcid.org/0000-0002-1435-9220

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V.A. Kasimov. *Emergence of spatio-temporal certainty (1+2+3)*

Abstract

The well - known philosophical formula: "Space and time are universal forms of existence of matter" forces us to introduce several levels of representation of our knowledge about space-time relations, which we will conditionally call "levels of ontologization" of our understanding of these relations. These levels can be considered as ontological sections in the process of cognition of the essence of spatiotemporal relations and the formation of their conceptual certainty.

A simple example is used to model the process of formation of spatiotemporal certainty in the Leibniz aspect: the transition from the quantum level (micro-) to the level of classical mechanics (macro-). In this regard, we can talk about the two-phase existence of matter. In addition, an attempt was made to outline the solution of space-time problems after work: "Contextuality of one particle, nonlocality of two particles, entanglement, Wheeler's experiments with delay of choice, FWT and so on ..."[12].

The current situation of the search for the essence of space-time relations resembles the early history of the search for the essence of "phlogiston", which was resolved by the statistical theory of Gibbs ensembles, the definition of thermodynamic concepts and, in particular, the concept of temperature as the average kinetic energy of the ensemble. It is quite possible that the spatiotemporal relations are also some averages from the eigenvalues of the quantum object operators.