

# Revealing the Uncertainty and Absolute Certainty Principles in the Kinetics of Objects Formation

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## Abstract

The paper presents some examples revealing the uncertainty and absolute certainty principles in kinetics of objects formation that are different in their physical nature and in space scales: sub-stances of microcosm, nanoparticles and mesostructures, astrophysical and cosmological objects. Under the proposed kinetic approach, the uncertainty principle covers a wider spectrum of processes of approaching to equilibrium and object formation, than the absolute certainty principle. It refers, in particular, to nano-range-of-problems and mesoscopics as well as to cosmology. Both principles predict formation of objects that are not well-known or, at least, well-described so far. Among these are neutron-rich super-heavy and giant nuclei, biologic and organic-silicon mesoobjects, cosmological objects with the sizes considerably exceeding the size of a light sphere.

## Keywords

Objects Formation, Kinetics, Principles, Uncertainty, Absolute Certainty, Microcosm, Nanoparticles and Mesostructures, Astrophysical and Cosmological Objects

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## 1. Introduction

The papers [1]-[6] consider principle issues of dynamics of quantum systems and description of object properties different in physical nature and in spatial scale: from substances of microcosm to cosmological structures. A special case here is the recent study into nanoclusters, nanostructures and nanomaterials. Kinetics of objects formation having various physical nature and revealing their quantum properties both in spatial scales of micro- and mesocosms, and in cos-

mic scales is considered in works [7] [8] [9] based on the concept referring to a wave  $\varphi(a, t)$  of density distribution in space of these object sizes  $a$  ( $t$  is the current time). In addition, a general issue about fields of application of concepts of quantum system dynamics under the uncertainty principle [2] [3] [4] and absolute certainty principle [5] has been put forward and partially studied. In the light of a universal relationship  $\Delta a \cdot \Delta k \geq 1/4\pi$  (resulting from Fourier theorem) for dispersions of a coordinate  $a$  and a wave number  $k$ , valid for a wave of any physical nature, in case of asymptotic coherent state of a quantum system, when dispersion product has the minimum value, and dispersions of values are replaced by values themselves, the uncertainty and absolute certainty principles are connected by a one-to-one correspondence [9]. It is shown that a type of the growth law for such objects depends on the fact, what exactly principle is assumed as a basis for consideration.

This paper gives summary, discussion and progress of the results from [7] [8] [9], in light of notions [1]-[6], using examples for formation of microcosm objects (elementary particles and atomic nuclei), nanoparticles and mesoobjects (diamonds, protein substances), astrophysical objects (neutron stars, white dwarfs, globular clusters of red giants) and the observable cosmological structures (superclusters of galaxies).

## 2. Results and Their Discussion

Derived in Refs. [7] [8] [9] phenomenological laws of  $a$  sizes growth of volume packed objects with the  $t$  time and expressions for their characteristic sizes in formats of the uncertainty and absolute certainty relationship within the space of sizes are given in **Table 1**.

Here  $\Delta p \sim p = m \Delta a / \Delta t$  is uncertainty of momentum  $p$ ,  $m$  is object mass,  $\Delta E$  is width of energy level  $E$  of the excited state of quantum mechanical system determined by nature of objects and a mode of process,  $\hbar$  is the reduced Planck constant,  $a_0, m_0$  is size and mass of an embryo,  $t_i$  is characteristic time scale of an elementary (single) act of objects interaction,  $\alpha$  is geometrical factor (for a cube  $\alpha = 1$ , for a sphere  $\alpha = \pi/6$ ),  $K_c$  is phenomenological action constant in cosmic scales,  $\rho$  is density of observed substance in the Universe,  $\rho_c$  is substance critical density at which the Universe becomes closed,  $c$  is light velocity. Physical meaning of the relationship between uncertainties “coordinate-momentum” is in the fact that during a period of time  $\Delta t \equiv t_i$  of elementary (single) act of objects interaction, the exact size of each object cannot be determined until this interaction is finished. It is associated with the fact that up to the end of the single act, it is impossible to determine the correlation between the object and each interacting surface element. In the format of absolute certainty, the relationship “coordinate-momentum” implies that at each time, the object under consideration is strictly localized within the space of sizes.

**Table 2** provides examples of how the above principles manifest themselves when describing formation of objects in the processes of approaching to equilibrium [7] [8] [9]. The given results are in agreement with the generally known

**Table 1.** Relationships, laws of growth and formulae for characteristic object sizes [7] [8] [9].

Objects	Uncertainty principle ( <i>un</i> )	Absolute certainty principle ( <i>ac</i> )
Microcosm and mesostructures	Relationship: $\Delta a \cdot \Delta p \approx \hbar/2$	Relationships: $ap = \hbar/2$ , $Et = \hbar$ Growth law $a^4 da = (\hbar/2\alpha\rho)dt$ Maximum size $a_{\max}^{ac} \approx \left(\frac{\hbar t_i^{\max}}{6m_0}\right)^{1/2} \equiv \frac{\hbar}{(6m_0 E_{\min})^{1/2}}$
	Growth laws: $\langle a \rangle^{3/2} d\langle a \rangle \approx \left(\frac{\hbar a_0^{3/2}}{2m_0 t_i}\right)^{1/2} dt$ ,	
	$\langle a \rangle^{3/2} d\langle a \rangle \approx \left(\frac{a_0^3 \Delta E}{2m_0}\right)^{1/2} dt$	
	Maximum size $a_{\max}^{un} \approx \frac{2m_0 a_0^3}{9\hbar \Delta t_{\min}}$	
Objects of astrophysics and cosmology	Relationships and growth law $ \Delta a  \cdot  \Delta p  \cong K_c/2$ , $ \Delta E  \cdot  \Delta t  \cong K_c$ $\langle a \rangle^2 d\langle a \rangle = (1/\sqrt{2})(\rho_c/\rho)^{1/2} a_0^2 c dt$	Relationships and growth law $ap \cong K_c/2$ , $Et \cong K_c$ $\langle a \rangle^2 d\langle a \rangle = (1/2)(\rho_c/\rho) a_0^2 c dt$

**Table 2.** Manifestation of principles in the processes of approaching to equilibrium [7] [8] [9].

Objects	Uncertainty principle	Absolute certainty principle
Microcosm	Formation of hadron jets from quarks	Formation of carbon nuclei in quark environment → carbon cycle in stars
	r-processes; deeply inelastic relativistic processes in nuclei Stable nuclei	s-processes
	Formation of super-heavy nuclei up to mass number $A_{\text{end}} \cong 470$	Formation of giant nuclei with $a_{\max}^{ac} \approx 1.6 \times 10^{-12} \text{ m}$
Mesostructures	Typical sizes of all known artificial and natural diamonds: from 0.7 nm to 20 μm	Typical size of a carbonado-type diamond ( $\approx 0.1 \text{ mm}$ )
	Characteristic sizes of protein nanoparticles, ribosomes and mesoobjects (archaea, cells): from $\approx 1 \text{ nm}$ to $\approx 7 \mu\text{m}$	Characteristic size of insulin ( $\approx 2 \text{ nm}$ )
Stars	Typical times of formation and a size of neutron stars: 0.17 - 17 s, 16 km	Typical times of formation and a size of neutron stars: 0.17 - 17 s, 16 km
Globular clusters of red giants	Average size is 200 ps (parsec)	
Superclusters of galaxies	Average size is 84 Mps (megaparsec)	Average size is 36 Mps

conceptions. One can see that under the proposed kinetic approach the uncertainty principle covers a wider spectrum of processes for objects formation as compared to the absolute certainty principle. At the same time, both principles mutually complement each other.

Thereby, the developed asymptotic method for investigating the kinetics of formation of objects with quantum properties, corresponding to the principle of intellectual asceticism [3] and statement [4] about adequacy of phenomenological description of physical phenomena or physical objects, has a sufficient level of generality to be used in problems of high energy density physics and in physical chemistry of high intensity processes. Below are the examples of how uncertainty principle and absolute certainty principle are applied in problems of objects formation in microcosm, nano- and mesocosm, and cosmos.

## 2.1. Microcosm

Based on the law of growth for objects in the format of the uncertainty principle [7] [9], it is possible to evaluate the value of fundamental mass in microcosm  $m_{fund}$ , if in compliance with the concepts in ref. [10], one accepts that the least spatial unity (fundamental length) is the value  $a_{fund} \approx 10^{-18}$  m, and that this value is matched by the time scale  $t_{un} = a_{fund}/c$ . In [7] the following equation for fundamental mass is given:

$$m_{fund} = \frac{\hbar}{ca_{fund}}. \quad (1)$$

It follows from here that  $m_{fund}c^2 = \hbar c/a_{fund} = 196$  GeV [7]. The obtained value approximately corresponds to the mass value of a dark matter particle determined in [11] according to the data of astrophysical observations and equal to 192 GeV. It should be noted that expression (1) is definitely connected with determination of Compton wave-length of a material particle  $\hat{\lambda} = \hbar/mc$ , and the above value of a fundamental length is adequate to the current concepts. However, the above value of fundamental mass has been obtained beyond general approaches and standard models [2].

## 2.2. Nanometric and Mesoscopic Objects

In the field of nanosized scale and mesoscopics the uncertainty principle covers the whole spectrum of object formation processes described in refs. [6], [12] [13] [14]. Two types of objects are considered: 1) clusters with the lattice formed of atoms of a single type, oscillating as harmonic oscillators with the typical frequencies  $\sim 10^{12} - 10^{14} \text{ s}^{-1}$  ("atomic" nanocrystals); 2) clusters formed by macromolecules revealing both oscillating nature of inner motions with the given frequencies, and rotational isomerism with the frequencies  $\sim 10^{10} - 10^{11} \text{ s}^{-1}$  ("molecular" nanocrystals). The question arises of whether there is any influence of collective quantum structure properties on the processes of their formation and growth and on the values of their typical sizes. As the objects of the first type, it is reasonable to consider crystals with covalent carbon bonds C-C *i.e.*, nanodiamonds characterized by expressed phonon effects associated with exchange interaction of atoms. As the objects of the second type, it is reasonable to consider protein nanoparticles consisting of amino acid molecules, since the latter are characterized by strong bonds of C-C, C-N and C-O type that provide

high-frequency oscillating constituent of internal motion, and by rotational isomerism and low-frequency component of spin-lattice relaxation creating conformational motion with the typical times  $\tau = 10^{-10} - 10^{-7}$  s.

In general, the mechanism of formation of macroscopic diamond particles from nanodiamonds described in works [7] [9] covers all available data about sizes relating to both artificial diamonds obtained in static and dynamic synthesis, and natural diamonds.

One of topical trends of nanoscience and nanotechnology consists in the creation and the study of biological materials, in particular, the study of physical mechanisms of protein biosynthesis [6] [12]. In accordance with the results of the investigations the commonly accepted scheme of proteins construction is presented in such a manner that a volumetric-packed nanoparticle that represents an aperiodic crystal, is formed from nanochains with the C-N peptide bonds (primary structures) as a result of the twisting and the mutual arrangement of various polypeptides in the presence of nucleic acid molecules.

At the same time, in [9], there is another scheme of arrangement of biological nanoparticles, in which as a result of rotational-vibrational interaction of amino acid molecules, their volumetric polycondensation can occur. The seeding centers of polycondensation can be the molecules of nucleic acids, around which amino acid molecules are grouped. They are grouped in a certain order given by preferable formation of C-N bonds as the most short and strong bonds as compared to C-C and C-O bonds. In the proposed in [9] way of considering the corresponding mechanism of protein nanoparticle synthesis, the principle of uncertainty assumes the possibility of mutation of biological objects at a molecular level. Based on typical sizes and masses [12] of embryos (molecules of amino acids of glycine, alanine, valine and tryptophan), there have been determined the following vicinities of the most probable sizes and “magic” sizes, corresponding to proteins [6] [12] [14]: (1.4 - 1.7); (2.2 - 2.5); (2.7 - 2.9 - 3.3); (4 - 4.6 - 4.7); (5 - 5.5 - 5.6); (6 - 6.7 - 7); (8 - 8.5); 9; 10; 11; 12; 14; 15; 16; 17; 18; 19; 20; 21; 22; 23 nm. The maximum sizes  $a_{\max}^{m}$  of mesoobjects from above listed embryos have been calculated by corresponding formula of **Table 1** and provided the values 0.6; 1.1; 2.1 and 7  $\mu\text{m}$  [9]. These values correspond to lysosomes, mitochondrions, red cells, thrombocytes, and small lymphocytes. For example, if molecules of the “smallest” amino acid—glycine with  $m_0 = 1.25 \times 10^{-25}$  kg,  $a_0 = 0.42$  nm [12] are regarded as embryo, from above mentioned formula we gain that the greatest size of objects is equal to  $a_{\max}^{m} \approx 0.6 \mu\text{m}$  [9]. The calculated results [9] testify to the fact that at the “instant” excitation of a biological system, e.g., under absorption of the radiation energy of various nature, it is possible that nanoparticle and mesoobject significantly increase in sizes, and low density lipoproteins and leucocytes are formed. This fact does not contradict to the known medical facts of formation of mutations and tumors or development of atherosclerosis and leukemia under the effect of ray penetration into an organism.

In case of continuous protein nanofibres (linear nanostructure), one can use the method from [7] and obtain the following expressions for determining typical values of the thickness  $d$  and the length  $l$  of the objects:

$$d = a_0 \left( \frac{2m_0 a_0^2}{\hbar t_i} \right)^{1/4}, \quad (2)$$

$$\langle l \rangle = \left( \frac{\hbar}{m_0} t \right)^{1/2}. \quad (3)$$

With the typical parameter  $t_i \equiv t_R = 2\pi\hbar b/k_B \sqrt{2\theta_R T}$  [15] corresponding to rotational molecule isomerism ( $k_B$  is Boltzmann constant,  $b$  is a number of crystal-forming bonds,  $\theta_R$  is the typical rotational bond temperature ( $\approx 2.6$  K),  $T$  is ambient temperature), we derive from the formula (2) that for the embryos like glycine (the least amino acid with  $m_0 = 1.25 \times 10^{-25}$  kg,  $a_0 = 0.42$  nm [12]) and tryptophan (the highest amino acid with  $m_0 = 3.4 \times 10^{-25}$  kg,  $a_0 = 0.67$  nm [12]) at  $T \approx 310$  K, the diameters of nanofibres are equal to 1.27 nm and 2.35 nm. These values approximately correspond to the thicknesses of collagen protein ( $\sim 1$  nm [12]) and myosin protein (2.5 nm [16]). If we assume that to form the nanofibre thickness, it is sufficient to have a single oscillation of a “last bond” of the longest molecule of tryptophan embryo and  $t_i \approx 3 \times 10^{-14}$  s [9], then from formula (2) we get  $d \approx 11.6$  nm. This approximately corresponds to the thickness of a continuous neurofibril of a human, neurofilament, approximately equal to 10 nm [17]. Calculation according to formula (3) shows that to form a neurofilament 300 nm long, one requires approximately 100  $\mu$ s.

Thereby, the results from the relationship “coordinate-momentum” in the space of object sizes are indicative of the fact that in the system of amino acid molecules, accidental formation of quasi-crystalline nanoparticles and mesoobjects corresponding in their sizes to essential proteins and cells is possible. These “incorrect” (mutational) objects can grow on these or those crystallization centers without formation of polypeptide bonds, *i.e.*, without formation of “correct” biological code. At the same time formation and growth of such nanoparticles and mesoobjects is possible on fragments of damaged proteins and cells as on the centers of crystallization. All this is in compliance with the generally known concepts concerning mutations of biological structures at a molecular level.

As for the all-known ideas concerning possible origin of life on the Earth as a result of amino acids brought onto the Earth from space, in [9], in the format of the uncertainty principle, it is shown that the objects with sizes from 30 - 45 nm (ribosomes, inside which protein synthesis occurs) to 0.4  $\mu$ m (nanosized protozoan) can be generated from amino acid fragments formed under impacts of meteorites against the earth surface.

### 2.3. Astrophysics and Cosmology

With reference to the processes of cosmic scale, it should be noted that the uncertainty principle [8] predetermines currently observed Universe accelerated

expansion described by de Sitter cosmological model and Hubble law [2]. In addition the estimated radius of a cosmic sphere  $R_c \cong 4.5 \times 10^{27}$  m including the great number of independent from each other groups of universes that interact between themselves inside each group within a “light” sphere with the radius  $R_{\text{light}} \cong 1.323 \times 10^{26}$  m, reasonably corresponds to a cosmic radius  $R_{cB} \cong 5.89 \times 10^{27}$  m, determined in [18] based on relationship between physical constants. The existence of multiple interacting universes does not contradict the statement about existence of a set of images of a “unique specimen” [18].

One can try to evaluate the range of “rigid” sizes of astrophysical and cosmological objects based on the principle of absolute certainty. In case of supernova explosion, one should substitute Planck constant in the proper formula of **Table 1** by the determined in [7] phenomenological action constant in the “World” of collapsing stars equal to  $K_G = M_{Ch}^2 G_N / c = 1.72 \times 10^{42}$  J·s ( $G_N$  is a gravitation constant,  $M_{Ch}$  is Chandrasekhar critical mass starting from which a star begins to collapse):

$$a_{\text{max}}^{ac} = \frac{\hbar}{(6m_0 E_{\text{min}})^{1/2}} \rightarrow a_{\text{max}}^{astr} = \frac{K_G}{(6m_0 E_{\text{min}})^{1/2}}.$$

The minimum value of the carried away energy at supernova explosion is equal to  $E_{\text{min}} = 10^{41}$  J [19]. As a seed mass, we will formally accept Chandrasekhar limit  $m_0 = M_{Ch} \cong 1.4 M_{Sol}$ ,  $M_{Sol}$  is the mass of Sun [20]. Hence, we obtain that  $a_{\text{max}}^{astr} \cong 1.36 \times 10^6$  m that approximately corresponds to the size of a white dwarf [20]. To determine the maximum possible cosmological size, one should substitute into the proper formula  $a_{\text{max}}^{ac} = (K_c t_i^{\text{max}} / 6m_0)^{1/2}$  the limit value of the cosmological action constant determined in [8], [9] as  $K_c^{\text{lim}} = M_c^2 G_N / c$ . Here,  $M_c = m_p N_b (\rho_c / \rho) \cong 5.5 \times 10^{54}$  kg is cosmic mass determined as a product of baryon mass and the ratio between critical density and baryon density,  $m_p$  is proton mass,  $N_b \approx 10^{80}$  is baryon number in the Universe [2]. We will accept the value  $M_c$  as embryo mass. Then with  $t_i^{\text{max}} = a/c$  we obtain the expression for a “new” phenomenological constant that determines the value of the maximum cosmological size  $a_{\text{max}}^c$  in the format of the absolute certainty:

$$a_{\text{max}}^c = \frac{M_c G}{6c^2} \cong 6.7 \times 10^{26} \text{ m}$$

The set spatial range  $1.36 \times 10^6 - 6.7 \times 10^{26}$  m includes the sizes of objects from dwarf stars to the observed space domain (light radius is approximately equal to  $1.323 \times 10^{26}$  m). In particular, it refers to a size of supercluster of galaxies evaluated in [9] as  $1.11 \times 10^{24}$  m = 36 Mps (megaparsec) that reasonably corresponds to the observed value 30 Mps [20]. Presented results supplement fundamental notions [1].

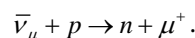
### 3. Issues for Further Studies

In terms of evolution of the results, one can try to consider the possibility of formation of objects that have not been yet discovered or are not widely known and

therefore, are not described in scientific literature in details.

### 3.1. Super-Heavy and Giant Nuclei

In microcosm in the format of the uncertainty principle, such an object can be a final nuclide with a mass number near to  $A_{end} \cong 470$  [7]. In [9], in a format of the absolute certainty, there is a prediction of existence of giant nuclei with the size  $a_{max}^{ac} \approx 1.6 \times 10^{-12}$  m. The evaluated size of a hypothetical giant nucleus is in an order of magnitude a thousand times greater than the spatial scale  $\sim 10^{-15}$  m of strong interaction between nucleons in usual nuclei. Due to Coulomb repulsion of protons, nuclear forces cannot hold compactly such a huge system consisting of protons and neutrons bound by just strong interaction. It should be noted that the calculated nucleus size corresponds in an order of magnitude to the Compton wavelength of muon neutrino/antineutrino with the rest mass  $m_{\nu_{\mu}} = 0.19$  MeV [21]:  $\lambda = \hbar/cm_{\nu_{\mu}} = 1.05 \times 10^{-12}$  m. It is reasonable to assume that inside such nucleus under the effect of muon antineutrino, a well-known reaction [21] takes place, *i.e.*, disintegration of a proton into neutron and a positively charged muon:



This reaction assumes formation of “neutron” nuclei in material domains rich in muon antineutrino. The latter are particles “gluing” giant nuclei from inside similarly to what pions do in usual nuclei [21]. Apparently, such hypothetical nuclei can be near to neutron star surfaces (in a crust or liquid domain), where heavy nuclei are located [20] [21].

The abovementioned similarity of muon antineutrino and pions implementing the strong interaction between nucleons in nuclei [21], allows us to put a question whether muon antineutrino are carriers of some type of interaction between nucleons inside giant nuclei similar to strong interaction. **Table 3** provides comparison of characteristics of these two types of interaction. One can see that Yukawa potentials inside the considered nuclei are comparable in an order of magnitude. Right this makes the existence of hypothetical giant nuclei possible.

**Table 3.** Interaction characteristics between nucleons inside nuclei.

Nuclei	Usual [21]	Giant [9]
Type of interaction	Strong	Assumed
Carriers	Pions	Muon antineutrino
Rest mass $m, \text{ MeV}$	139.57	0.19
Compton wavelength $\lambda = \hbar/m, c, \text{ m}$	$1.46 \times 10^{-15}$	$1.05 \times 10^{-12}$
Nucleus radius $R, \text{ m}$	$\sim 10^{-14}$	$\approx 0.8 \times 10^{-12}$
Yukawa ratio, $\text{m}^{-1}$ $U_{nuc} \sim \exp(-R/\lambda)/R$	$\sim 10^{12}$	$\approx 3 \times 10^{11}$



### 3.2. Nanoproblems and Mesoscopics

In nano-range-of-problems and in mesoscopics the following important issues can be determined: 1) capability check for formation of protein nanoparticles in conditions of relatively low temperatures (e.g. in deep waters); 2) search for new unknown or little-known biological nanoparticles and mesoobjects. Below are some qualitative considerations referring to the given issues.

1) Formulae [7] for calculation of average size nanoparticles in Debye approximation are overwritten in the following way:

$$\text{Small flux of embryos: } \langle a \rangle \approx \left( \frac{75k\theta_D}{8\pi\rho} \right)^{1/5} t^{2/5}, \quad (4)$$

$$\text{Large flux of embryos: } \langle a \rangle \approx \left( \frac{27k\theta_D a_0}{2 \cdot 6^{1/3} \pi^{5/3} \rho} \right)^{1/6} t^{1/3}. \quad (5)$$

It has been accepted that Debye parameter  $\theta_D$  approximately corresponds to the averaged characteristic oscillation temperature of bond expansion (C-C, C-O, C-N) of 1500 K [15]. From formula (5) we obtain that for the time of “fast” conformational motions  $10^{-10}$  s [6], in the mode of a large flux of embryos (tryptophan molecules), there can grow protein nanoparticles with the size 1.6 nm. The found size corresponds to a globular protein (myoglobin) [6] which in considerable quantity is present in muscles of whales [22]. In the mode of a small flux of embryos, from formula (4), we obtain that in amino acid environment with the density of  $\rho \sim 10^3 \text{ kg} \cdot \text{m}^{-3}$ , protein nanoparticles with the size 3.6 nm can grow for the same time. If we consider the growth of protein nanoparticles for the time of “slow” conformational motions  $10^{-7}$  s [6], then from formula (5), in the mode of a large flux of embryos (tryptophan), we obtain that the average size of nanoparticles is 16 nm. From Formula (4), we obtain that in the mode of a small flux of embryos, protein nanoparticles with the average size about 60 nm can grow in amino acid environment with the density of  $\rho \sim 10^3 \text{ kg} \cdot \text{m}^{-3}$ . The calculated values overlap the entire known range of protein nanoparticle sizes [6] [12] [14].

2) In the format of absolute certainty with the average density of amino acids  $\rho = 1.3 \times 10^3 \text{ kg} \cdot \text{m}^{-3}$  [12] from the equation of **Table 1**  $a^4 da = (\hbar/2\alpha\rho) dt$ , we obtain that for the time from one million of years (conditional time after a large cosmic body that has brought amino acids in it, strikes the Earth surface) to approximately 5 billion of years (Earth age [23]), mesoobjects with the sizes from  $\approx 30 \mu\text{m}$  to  $\approx 140 \mu\text{m}$  can grow. These can be crystal skeletons of microorganisms (bacteria) formed in out-of-the-way places (glaciers, caves, extinct volcanoes, deep waters and so on).

Organic-silicon mesoobjects [24] with  $\rho = 0.93 \times 10^3 \text{ kg} \cdot \text{m}^{-3}$  can have the related sizes. The basis of these mesoobjects is siloxane skeleton—the chain of alternate Si and O atoms [24]. Elementary portion of such polymer chain consists of two adjacent atoms Si and attached atoms C, H, O. Replacement of some H atoms by N, F, S, and Fe atoms results in analogy with biological polypeptide

nanochains [12]. Such analogy expands a range of questions related to the study of life as a nanoscale phenomenon [14].

Based on the data on atomic radii and the lengths of interatomic bonds [25], it is possible to evaluate an embryo size of a rubber polymer as  $a_0 \cong 0.4$  nm. Resulting from the mentioned value of average density of organic-silicon components, we will determine the mass of the least sphere-shaped embryo as  $m_0 \cong (\pi/6) \rho a_0^3 \cong 3.09 \times 10^{-26}$  kg. Then, under the principle of uncertainty according to the **Table 1** formula, one can evaluate a typical size of a globular organic-silicon nanocrystal as

$$a_{\max}^{un} \approx \frac{2m_0 a_0^3}{9\hbar \Delta t_{\min}} \cong 60 \text{ nm} ,$$

where  $\Delta t_{\min} = 1/\omega_e c = 7 \times 10^{-14}$  s ( $\omega_e \cong 10^5$  m<sup>-1</sup> [25]). This size in a scale of magnitude corresponds to the sizes of biological equivalents (ribosomes) [12]. If similar to translational crystal symmetry, we accept  $a_{\text{trans}} = 2a_0 \cong 0.8$  nm as an embryo size, then the evaluated typical size will increase a factor of  $2^6 = 64$  :

$$a_{\max}^{un} \approx \frac{2m_0 a_{\text{trans}}^3}{9\hbar \Delta t_{\min}} \cong 4 \text{ } \mu\text{m} .$$

This size in a scale of magnitude corresponds to the sizes of biological mesoobjects [12] and protozoa (archaea) [26]. The calculated sizes can be significantly increased, if we substitute a part of H atoms by significantly heavier atoms contained in standard biological organisms. The issue of existence of such hypothetical biological structures, containing silicon, remains open. It looks reasonable to search for the mentioned structures in places, where rubber-bearing plants grow.

### 3.3. Maximum Cosmological Objects

With reference to unobservable cosmological objects, cosmic sphere [8] with  $a_c \cong 9 \times 10^{27}$  m and the calculated above maximum cosmological object with  $a_{\max}^c \cong 6.7 \times 10^{26}$  m are not considered by cosmological standard models [2].

## 4. Conclusions

The method for studying kinetics of formation of objects with quantum properties regarding for uncertainty and absolute certainty principles has been developed. This method is based on the concept of distribution density wave in the space of these object sizes. It is shown that a type of the growth law for objects depends on the fact, what exactly principle is assumed as a basis for consideration.

Substances of microcosm, nanoparticles and mesostructures, astrophysical and cosmological objects have been considered. The obtained results are in agreement with the generally known conceptions.

Under the proposed kinetic approach, the uncertainty principle covers a wider spectrum of object formation processes than the absolute certainty principle. It

especially refers to nano-range-of-problems, mesoscopics, and to cosmology.

Both principles predict formation of objects that so far are not widely known or, at least, well described in scientific literature. Among these are neutron-rich super-heavy and giant nuclei, biologic and organic-silicon mesoobjects, cosmological objects with the sizes considerably exceeding the size of a light sphere.

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