Multidimensional Treatment of the Expanding Universe

Abstract

The simplest six-dimensional treatment of the expanding Universe in the form a three-dimensional sphere appeared as a result of the intersection of three simplest geometrical objects of finite sizes in the six-dimensional Euclidean space – of three uniformly expanding five-dimensional spheres – with account of an increase of speed of light in cosmic time (a measure of expansion of five-dimensional spheres) is given. Its effect on redshift for distant sources and theoretical redshift dependencies compared with observed data are demonstrated. A scenario in which the speed of elementary particles, including photons, in the six-dimensional space is constant in cosmic time is considered. This scenario corresponds to the energy conservation condition in that space. Some difficulties of standard cosmology are discussed on the base of six-dimensional cosmology. Recurrent formulas generalized the theory on the case when three original perturbations in the form of $(N-1)$- dimensional spheres expand in N -dimensional space.

Keywords: multi-dimensional space, cosmology, redshift

1. Introduction

The space-time in which the true Lorentz transformations, is commonly considered to be pseudo-Euclidean and the interval of the theory of relativity − element of the particle trajectory in space-time. However, in Euclidean spaces with the number of spatial dimensions of a large three the Lorentz transformations are obtained elementarily, if the proper time of an elementary particle assumed to be proportional to the path traversed by it in the extra space (Y), supplementing the observed three-dimensional space (X) until a multidimensional space, provided that the elementary particles like photons, moving at the speed of light in the whole space [1]. This explains the paradox of twins: the faster the object moves in a X, the slower its speed in the complementary subspace Y of the total space, and hence the slower the flow of his own time.

Widely it is discussed indefinite question 'What is time?' However, in the formulas of the theory of relativity appears only the proper time, various in different reference frames. In this context, it makes sense to only the question 'What is the proper time?' The proper time is an integral measure of the movement of elementary particles in the complementary subspace of multidimensional space, while the proper energy and the proper momentum are differential measures of movement in the complementary subspace Y in the case when movement in X is absent. The proper time is proportional to the path traversed by the particle in the complementary subspace, and the velocity of the particles in the whole Euclidean (not pseudo-Euclidean!) space equal to the speed of light.

However, it does not follow that the speed of light is constant in time and even has always been different from zero. Cosmological time should not be to define through the speed of light, if this speed can be equal to zero. Cosmological time used to describe the evolution of the Universe, should determine on the basis of the initial cosmological process that led to the observed occurrence of a three-dimensional universe and allowing the process to establish a link between the expansion rate of the universe and the speed of light. Cosmological time should be defined so that we can answer the question: 'What was before the emergence of the observed three-dimensional Universe and what has led to its emergence?' However, we need to know the number of dimensions of space in which there is an evolution of the universe. The geometric model of the universe must be constructed in accordance with the principle of simplicity [2]. The multidimensional interpretation of the Lorentz transformation opens the opportunity of an adequate multidimensional treatment of the origin and evolution of the three-dimensional Universe. The need for a multidimensional cosmology is seen from the fact that the Universe is very homogeneous in a large cosmological scale. Therefore, it is a three-dimensional sphere. This sphere can be expanded, and only in the space of a higher number of dimensions than 3. Similarly, N-dimensional sphere may only expand in the space of a higher number of dimensions than N. *Homogeneous* universe can expand in itself only if it has the shape of a plane or hyper-plane. Such universe has no beginning, her age is endless, but the question is why, however, the density of matter in it during its expansion is finite if it is our world, and it exists indefinitely, has no answer.

Note that the volume of a three-dimensional universe from a geometric point of view, there is a three-dimensional hyper-area corresponding area on the three-dimensional sphere.

The evolution of the three-dimensional universe depends on the dimensionality of the total space. A simple explanation of the spin and isotopic spin requires six spatial dimensions [1, 3-5]. Therefore, in cosmology, based on the principle of simplicity, the number of spatial dimensions also can not less than six.

The light and particulate substance has both wave and particle-properties. Electron diffraction and photo effect indicate that the basic properties of substance particles and the light is the same. The basic property of light is that in the absence of gravity, it propagates with equal velocity in any frame of reference. Therefore, the particles of the substance must move at the speed of light, what is only possible in a multidimensional space.

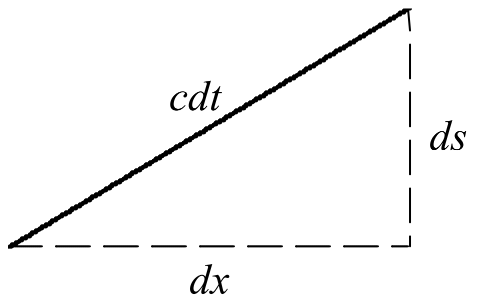


Figure 1: Projections *ds* and *dx* of displacement *cdt* of a particle moving at the speed of light in the whole space. These three quantities are related to the Pythagorean theorem.

All directions in the subspace *Y* of the Euclidean multidimensional space are perpendicular to any direction in the three-dimensional subspace *X*. For this reason, projections *ds* and *dx* of a displacement of the particle moving at the speed of light in the whole space of any number of dimensions, respectively on the subspace *Y* and *X*, are connected by Pythagorean theorem:, $(cdt)^2 = ds^2 + dx^2$ where cdt is displacement of the particle in the whole space per the time dt (See Fig. 1). Hence, we obtain the metric of the special theory of relativity: $ds^2 = (cdt)^2 - dx^2$.

Elementary particles can't be removed from the three-dimensional universe at large Compton distances and must be held near universe by forces of cosmological nature. Otherwise, the trajectory of the elementary particles in additional to the three-dimensional subspace of the universe would not be compact and macroscopic bodies would not be possible. These forces (sort of the Lorentz force, which particle mass plays the role of the charge) are perpendicular to all directions of the three-dimensional subspace. They cause compactification of particle trajectories in the complementary subspace, resistance to centrifugal forces in it, but leaving the possibility of free movement of particles in the three-dimensional subspace. This provides the possibility of the existence of elementary particles and the formation of atoms, molecules and macroscopic bodies.

For any acceptable cosmological model the maximum of distribution of galaxies on redshift is of the order of one (actually there is a maximum at a redshift 0.7). The average density of galaxies for any acceptable model will be of the same order of magnitude as the observed value.

Metagalaxy radius is of the order 10^4 of average distances between galaxies. Therefore, non-uniform on angular coordinate part of the microwave background should be as many times smaller than the homogeneous part, what is really observed. Moreover, the inhomogeneous part of the microwave background must be due to the component of the spatial spectrum distribution of galaxies. It was detected the periodicity in the distribution of galaxies with a period of about 100 Mpc [6]. The observed maximum of 200-th spherical harmonics in the angular spectrum of the non-uniform microwave background corresponds to the spatial period of the same order. Of course, comparative periods do not have to be exactly equal to each other, as the microwave background is analyzed in the projection of the celestial sphere.

To compare the observed data with the theoretical, it needs to know the value of the Hubble constant (H_0). According to [7], it amounts to 74.2 +/- 3.6 km/s Mpc. However, this value is obtained using the equations of Einstein's cosmology. Indeed, the paper [7] is divided into two parts. In the first part, on the observations of cosmologically near supernova is found the value of the Hubble constant $H_0 = 47^{+14}_{-12}$ km/s Mpc. At this stage, the Einstein's equations are not used. At the second stage, with a view to verifying the result the authors of [7] used limitations based on the use of Einstein's equations in cosmology. This restriction was chosen in preference to the result of the first phase of the work. In the end, the result of 74.2 +/- 3.6 km/s Mpc turned up far beyond of the upper limit 47 + 14 = 61 km/s Mpc for the confidence interval of the Hubble constant on the first phase of work.

Six-dimensional interpretation of the expansion of the universe is not using the Einstein equations and contains five independent parameters, in contrast to the six parameters of the standard cosmology. In the 6D cosmology the Hubble constant is consistent with the result of $H_0 = 47^{+14}_{-12}$ km/s Mpc obtained in the first phase of work [7] without the use of Einstein's equations. In fact, almost the same result ($H_0 = 55^{+7}_{-7}$ km/s Mpc) was obtained earlier by G. A. Tamman [8].

Standard cosmology has other contradictions and shortcomings.

● In 1997, a supernova SN 1997ff was discovered at redshift 1.7 and a brightness of 1.5 times less than the prescribed standard cosmology. To resolve this discrepancy between theory and experiment had the cosmological constant set equal to the value at which the deceleration parameter expansion of the universe q_0 was negative, which corresponds to the acceleration of the expansion of the universe, rather than slowing down as previously thought [9]. However, according to Kellermann [10] , who measured the angular dependence of a size double radio sources, the linear size of which is estimated at 41 pc, with redshift z and compare it with the corresponding results of theoretical curves, it is clear that a satisfactory agreement with the observations is achieved only at $q_0 = 0.5$. For the remaining two values of q_0 the discrepancy between theory and observations is unacceptably high (see Fig. 2). If $q_0 < 0$ it more. Therefore, the introduction into the equations of the theory of cosmological term does not help. However, the opinion of experts was confirmed that ‘Gurvits corrected this error of Kellermann’ and that in the subsequent joint publications the problem is removed. However, in a joint paper [11] of these authors, published six years after [10], it is noted that all the previous results on the subject remain in force. In fact, in [11] to the previous data added new data relating to the radio sources are smaller in size (consider the cases for which $\ell h =$ 9.6 pc and 22.7 pc, where ℓ the linear size, h is the Hubble constant carried to 100 km/s Mpc.

In [11] it used 330 sources to 79 in [10]. The less a linear size the greater the error in measuring the angular size of the source. As a result of ‘dilution’ of previous data with new, confidence intervals are increased so much that they went to the bottom edges of the range of angles corresponding to negative values q_0. This created the appearance of well-being. However, the data of [10] are statistically self-sufficient, have smaller confidence intervals and clearly demonstrate the impossibility of matching the standard theory for negative values q_0 with the observations.

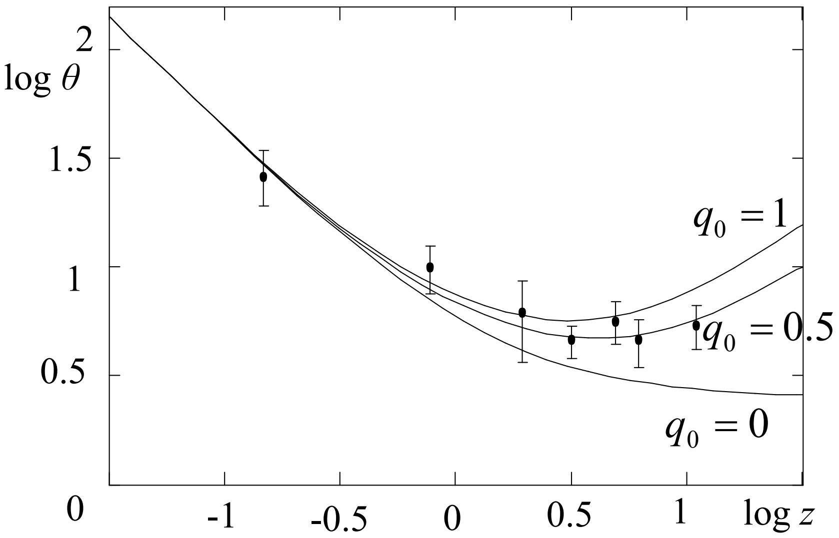


Figure 2: The dependence of the angular size of the double radio sources (in angular milliseconds) with the linear size of 41 parsecs on redshift z.

● The maximum of distribution of galaxies on the redshift $z = 0.72$ is observed at [12]. In the book [13] a formula is given for the density of matter in the universe $n(z,\Omega)$,

$$n(z,\Omega) = 4\frac{\left[\Omega z + (\Omega - 2)\left(\sqrt{1+\Omega z} - 1\right)\right]^2}{\Omega^3 (1+z)^3 \sqrt{1+\Omega z}},$$

depending on redshift z and the ratio Ω of the density of matter to the critical density, but calculations according to this formula were not performed. At the critical density the maximum of this function is placed at too large value $z = 1.7$ of the redshift compared with the corresponding observations, $z = 0.72$. According to this formula, the maximum is in the right place at the relative density $\Omega = 6.4$ unacceptably large for the standard cosmology, considering that the density is critical. Accounting for the cosmological constant does not help, as its increase (starting in the zero) acts opposite to increase the density of matter, so that the discrepancy between theory and observation will only increase.

● Observations show that at high redshifts the metallicity of galaxies and intergalactic gas – the relative density of the chemical elements more massive than hydrogen and helium – does not depend on redshift [14]. These chemical elements are formed by supernova explosions, the formation and heating of which need sufficient time. According to standard cosmology, the time corresponding to a given value z and measured from the beginning of the expansion of the universe tends to zero as z growth. When at the same time to supernovae occur and prepare for an explosion? Without the answer to this question it gives the impression that there were galaxies in the universe is in a ready state. With respect to quasars it is clearly indicated by the impression [15] already in 1995.

● According to [16], the maximum rate of star formation is observed at $z = 1.1$. Explanation of this fact, the standard cosmology does not and does not contain any mechanism that could be responsible for this fact.

2. Six-dimensional physics capabilities

Before discussing the results of the six-dimensional cosmological assumptions give a six-dimensional interpretation of physics. Note that the same dispersion equation holds for electromagnetic and acoustic waveguide, and for the de Broglie waves: $v_{ph}v_g = c^2$ where v_{ph} is the phase velocity of the waves, c is the speed of the waves in an infinite medium, the group velocity of the de Broglie waves v_g is equal to the particle velocity. The main characteristic of any waveguide is that it has finite cross-section sizes. They are responsible for the wave dispersion. This indicates that the portion of the space, with which we are dealing in the experiment, is only approximately three-dimensional one, with a very small dimensions (Compton, as is evident from a consideration of the properties of spin and isotopic spin) of the additional subspace. The equation of wave dispersion is a consequence of the perpendicularity of rays to the wave fronts.

Six-dimensional interpretation of physics, including gravity, based on the principle of simplicity [2]. It fits Einstein's assertion that 'nature saves on the principles', and the assumption of the identity of the basic properties of matter and light, as exemplified by the diffraction of electrons and the photoelectric effect. This assumption goes back to the idea of F. Klein [17-19] of the motion of the particles with the speed of light in a multidimensional space in which the mechanics are presented as quasi-optics. The first justification of a six-dimensional space is given by di Bartini in [20], where the fundamental physical constants are calculated.

The main property of light is that, in the absence of gravity, it propagates at the same speed in every frame of reference. If the main properties of substance and light are the same, which corresponds to the principle of simplicity, then the particles of matter must move at the speed of light, which is only possible in a multidimensional space. Further assume that the substance particle travel at the speed of light in a multidimensional space in the Compton neighborhood of three-dimensional sphere. This means that each elementary particle is acted by a cosmological force orthogonal to the three-dimensional sphere. It holds a particle at Compton distance from this sphere. Without such a force there would be no macroscopic bodies. Whole space is considered to be Euclidean and at least a six-dimensional one, because for it the simple interpretation of the spin and isotopic spin is possible.

We believe that in the whole multidimensional space the formulas of Newtonian mechanics are applicable for a suitable choice of the proper time specified below, and that the position of the particle is fixed by an observer in three-dimensional projection on the subspace $x_1\, x_2\, x_3\,(X)$ tangent to the three-dimensional universe as a three-dimensional sphere in R_6 at the location of the observer. In this case, the Newton's formulas referred to R_6, when projected of the events on X, give the formulas of relativistic mechanics, the Lorentz transformations, the interval of the theory of relativity, spin and isotopic spin, the proper magnetic moment, the de Broglie waves and wavelength, the fine structure formula, the Klein − Gordon equation, CPT-symmetry, the quark model of particles composed of u- and d-quark, the description of gravity [1, 3-5 , 21, 22]. For this description, it uses a small section of the universe in the cosmological scale, neglecting the curvature of the universe. Six-dimensional interpretation of the evolution of the universe at a stage where its radius is large compared to the distances between the centers of the perturbations in the whole space, which led to the formation of the universe, is given in [23, 24].

A particle fixed in a projection on X in an inertial frame of reference K of the 'fixed' observer is moving at the speed of light c, in the simplest case, on a circle in a three-dimensional subspace $y_1\, y_2\, y_3\,(Y)$, supplementing X to R_6, with the center of the circle in X. In any other inertial reference system the particle moves along a helical line (curve 1 in Fig. 3) on the cylindrical surface (tube of motion, TM) in R_6 with the axis belonging to X. The proper time of the particle is considered to be proportional to the length of its path in Y. This length is proportional to $|\cos\theta|$ where θ is the angle of the slope of the helical line to the directrix of the tube (see Fig. 3).

If the particle makes one revolution for proper time τ, then, by the clock of 'fixed' observer relative to which the particle moves along the tube at a speed $v = c\sin\theta$, it will happen over time $t = \tau / |\cos\theta|$, where $\sin\theta = v/c$, $\cos\theta = \pm\sqrt{1-(v/c)^2}$. Here and below, a positive sign refers to a particle revolving around the tube axis in the positive direction, negative − to antiparticle, revolving in the opposite direction. Oppositely charged particles revolving around the axis of the tube move in opposite directions. Antiparticles have opposite charges and rotate in opposite directions. Under time reversal particle must be moving backwards in its path on the same helical line and therefore rotate in the opposite direction. Hence, the sign of its charge should be changed so that the particle must be transformed into its antiparticle. The motion of the particle will be mirrored. Taken together, these properties of the particles and antiparticles constitute the content of CPT-theorem.

The lapses of the proper time of particle (or antiparticle), $d\tau$, and the time of fixed observer, dt, are connected by the relationship

$$dt = \pm d\tau / \cos\theta = d\tau \Big/ \sqrt{1-(v/c)^2}. \qquad (2.1)$$

In the fixed frame of reference, K, a particle has a velocity component $c \cdot \cos\theta$ along the directrix. The proper time of the particle in terms of a stationary observer, according to (2.1) is also proportional to $\cos\theta$, so that the particle and in its own reference frame K' is moving with the speed c. The displacement of particle to the interval ds on the directrix of TM and corresponding to it a turning to the angle $d\alpha = ds/a$ around the axis of TM, where a is a radius of TM, are identical in any frame of reference. Designating through dx, in the system K, the projection of displacement $d\varsigma$ of particle over the surface of TM on its generatrix and using the Pythagoras theorem, we obtain that $ds^2 = (cdt)^2 - dx^2$. But if we consider this relation as initial, then from it follows $d\varsigma = cdt$, i.e., that particle moves in R_6 with the speed c.

A particle located at rest in X moves in Y with the speed of light. Therefore it has in Y the rest momentum (*i.e.* the proper momentum) $p_y = mc$, and the rest energy (*i.e.* the proper energy) $E = p_y \cdot c = mc^2$, where m is the mass of particle. It travels an interval $ds = \pm cd\tau$ on the directrix per proper time $d\tau$. In general, the total momentum of a particle is a vector directed along the tangent to its helical path on the tube motion and in magnitude p equal to the product of the particle mass m on the ratio of the path $d\varsigma = cdt$ traversed by it in the whole space to spent on this path the proper time $d\tau$: $p = m\dfrac{d\varsigma}{d\tau} = \dfrac{mc}{|\cos\theta|} = mc\Big/\sqrt{1-(v/c)^2}$. This is a relativistic formula for the total momentum of the particle [25]. While its total energy is $E = pc = mc^2\big/|\cos\theta| = mc^2\Big/\sqrt{1-(v/c)^2}$.

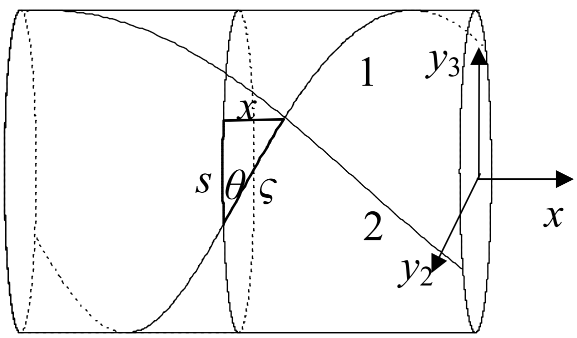


Figure 3: 1 − helical trajectory of a particle moving in a six-dimensional space with the speed of light on the cylindrical surface of Compton radius $\hbar/(mc)$ with axis in the subspace X and the directrix in the subspace Y; 2 – helical line intersects the helical trajectory at right angles and passes through the particle. It moves along the tube at the speed of de Broglie waves. Its step is the de Broglie wavelength. This is the line of the same proper time of the particle.

The rest energy must also be equal to $h\nu$, by virtue of the principle of the identity of the basic properties of substance and light, where ν is the frequency of rotation of particle around the axis of TM, h is the Planck constant. This implies that the radius of the tube is $a = \hbar/mc$, and the length of the directrix is equal to Compton wavelength, which corresponds to the period h of the action coordinate in the 5-optics [19]. Another helical line intersects the helical trajectory at right angles and passes through the particle. It moves along the tube at the speed of de Broglie waves. Its step is the de Broglie wavelength. This is the line of the same proper time of the particle [3-5].

3. Multidimensional geometric model of the universe

Six-dimensional interpretation of the expanding universe is also built on the principle of simplicity. The simplest geometric object of finite size in the six-dimensional Euclidean space is a five-dimensional sphere. Therefore, the simplest six-dimensional interpretation of the expanding three-dimensional sphere is its representation as the intersection of three five-dimensional spheres expanding in the six-dimensional Euclidean space − three five-dimensional spherical frontiers of disturbances propagating in this space. Thus it is assumed that these perturbations occurred as a result of three separate ‘explosions’ in the centers of these five-dimensional spheres. Point of first contact of the three five-dimensional spheres corresponds to the location of the center of the three-dimensional universe in the six-dimensional space.

However, we can’t exclude that the space is a seven-dimensional. In this case, the primary cosmological perturbations will take the form of six-dimensional spheres. While the question of the number of dimensions involved in the primary spherical perturbations, remains open, it is preferable to build a multidimensional cosmological model, assuming these perturbations N-dimensional.

These N-dimensional (*N*D) spheres are described by equations

$$\sum_{\alpha=1}^{N+1}\left(z_\alpha - z_{\alpha j}\right)^2 = R_{Nj}^2, \tag{3.1}$$

where z_α are the Cartesian coordinates in the $(N+1)$-dimensional space, $z_{\alpha j}$ the center coordinates of the j-th sphere, R_{Nj} its radius, $\alpha =$ 1, 2, ... *N*. The centers of spheres can be considered located in the plane $z_N\ z_{N+1}$, so that $z_{1j} = z_{2j} = ... = z_{(N-1)j} = 0$.

Intersection of two *N*D spheres is (*N* – 1)D sphere. Its center is located on a line passing through the centers of these *N*D spheres. The intersection of each pair of (*N* – 1)D spheres is (*N* – 2)D sphere centered on the line passing through the centers of these (*N* – 1)D spheres, etc. Thus, the intersections of three *N*D spheres are three (*N* – 1)D spheres which, in turn, intersect to form a three (*N* – 2)D sphere, etc.

In a plane passing through the centers of the three *N*D spheres, the distance l_j between the centers are linked by the cosines theorem $l_j^2 = r_i^2 + r_k^2 - 2r_i r_k \cos\beta_j = (r_i - r_k)^2 + 4s_j$, where $s_j = r_i r_k \sin^2\frac{\beta_j}{2}$, $j = 1,2,3$, r_j are radii of these spheres at the intersection of all three spheres at one point on this plane (Fig. 4). Here, β_j is the angle between the ends of the segment l_j visible from this point, $i,k = 1,2,3$, $k \neq j$, $k \neq i \neq j$.

Unlimited expansion of 3D sphere can only occur at the same rate of expansion of the 3D spheres, it formed is. Otherwise expanding 3D sphere will change by compression, contraction and disappearance. Then simply confine ourselves to the case of expansion of three *N*D spheres with the same constant speed c_N, where the radii R_{Nj} are represented in the form $R_{Nj} = R + r_j$. Equality $R = c_N t$ introduces the cosmological time, measured from the moment of intersection of all 3D spheres in one point on the triangle with vertices at the center of the sphere. At this point, $R = 0$, and all spheres are sequential intersections of three *N*D spheres and spheres of lower dimension, have formed. For small r_j compared with the radii of *N*D spheres, arising (*N* – 2)D spheres have at time $t = 0$ respective small radii and pass through above point on the triangle.

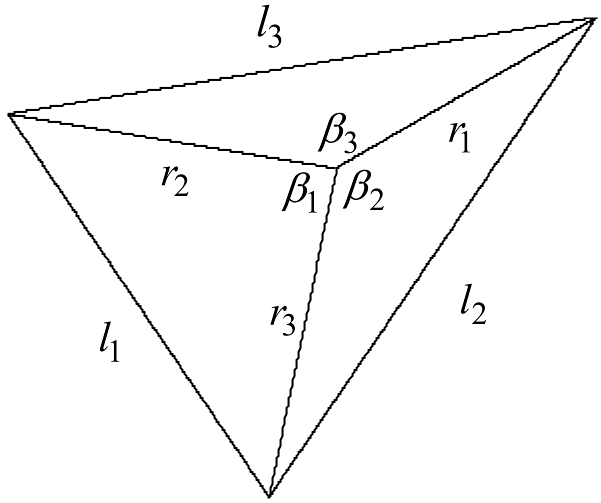


Figure 4: The radii r_j of three *N*D spheres in the plane on which the centers of spheres placed when the intersection of all three spheres is at one point. Centers of *N*D spheres are located at the vertices of the large triangle, l_j the distances between the centers, $j = 1,2,3$. In the case of the 6D space $N = 5$.

Consistent appearance of *n*D spheres with consequent reduction of n is described by recurrent formulas obtained from Fig. 5 in a plane passing through the centers O_{ni} and O_{nj} of two *n*D spheres. It is evident that equalities $R_{(n-1)k}^2 = R_{ni}^2 - d_{nij}^2 = R_{nj}^2 - d_{nji}^2$, $d_{nij} + d_{nji} = l_{nk}$, where d_{nij} and d_{nji} the distances from the center of $(n-1)$D spheres to the centers of the i-th and j-th n-dimensional spheres , respectively, give a consequence of the formulas:

$$d_{nij} = \left(R_{ni}^2 - R_{nj}^2\right)\frac{1}{2l_{nk}} + \frac{l_{nk}}{2}, \qquad d_{nij} - d_{nji} = \left(R_{ni}^2 - R_{nj}^2\right)\frac{1}{l_{nk}}, \tag{3.2}$$

$$R^2_{(n-1)k} = \frac{1}{2}\left(R^2_{ni} + R^2_{nj}\right) - \left(\frac{R^2_{ni} - R^2_{nj}}{2l_{nk}}\right)^2 - \left(\frac{l_{nk}}{2}\right)^2. \tag{3.3}$$

Applying the law of cosines to that shown in Fig. 5 triangle with vertices O_{ni} at the centers of *n*D spheres, similar to that shown in Fig. 4, and triangles, one of the vertices of which are also placed in these centers, and the remaining vertices − in centers of (n–1)D spheres, we can express the distance $l_{(n-1)i}$ between the centers of the (n–1)D spheres through the radii of *n*D spheres and the distance l_{ni} between their centers.

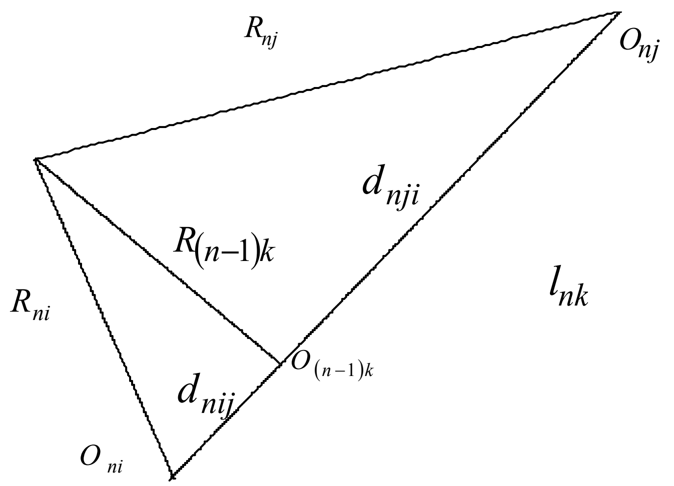


Figure 5.

We obtain $l^2_{(n-1)i} = d^2_{nij} + d^2_{nik} - 2d_{nij}d_{nik}\cos\alpha_{ni}$, $l^2_{ni} = l^2_{nj} + l^2_{nk} - 2l_{nj}l_{nk}\cos\alpha_{ni}$, α_{ni} is the angle at the apex O_{ni} of the triangle with sides l_{ni},

$$l^2_{(n-1)i} = d^2_{nij} + d^2_{nik} + \left(l^2_{ni} - l^2_{nj} - l^2_{nk}\right)\frac{d_{nij}d_{nik}}{l_{nj}l_{nk}} = = \left(l^2_{ni} - l^2_{nj} - l^2_{nk}\right)\left[\left(R^2_{ni} - R^2_{nj}\right)\frac{1}{2l^2_{nk}} + \frac{1}{2}\right]\left[\left(R^2_{ni} - R^2_{nk}\right)\frac{1}{2l^2_{nj}} + \frac{1}{2}\right] +$$
$$\left(R^2_{ni} - R^2_{nj}\right)^2\frac{1}{4l^2_{nk}} + \left(R^2_{ni} - R^2_{nj}\right)\frac{1}{2} + \frac{1}{4}l^2_{nk} + \left(R^2_{ni} - R^2_{nk}\right)^2\frac{1}{4l^2_{nj}} + \left(R^2_{ni} - R^2_{nk}\right)\frac{1}{2} + \frac{1}{4}l^2_{nj}. \tag{3.4}$$

In particular, when $n = N$ we have: $d_{Nij} = \left(R + \frac{r_i + r_j}{2}\right)\frac{r_i - r_j}{l_k} + \frac{l_k}{2}$, $a_k = \left(\frac{r_i - r_j}{l_k}\right)^2$, $a_i = \left(\frac{r_j - r_k}{l_i}\right)^2$,

$l_i^2\frac{1}{4} = \frac{r_j^2 + r_k^2}{4} - \frac{1}{2}r_j r_k\cos\beta_i = \frac{1}{4}(r_j - r_k)^2 + s_i$, $\quad s_i = r_j r_k \sin^2\frac{\beta_i}{2}$,

$$d^2_{Nij} = \left(R + \frac{r_i + r_j}{2}\right)^2 a_k + \left(R + \frac{r_i + r_j}{2}\right)\left(r_i - r_j\right) + \frac{l_k^2}{4}, \tag{3.5}$$

$$R^2_{(N-1)i} = \left(1 - a_i\right)\left[R^2 + (r_j + r_k)R + \frac{1}{4}(r_j + r_k)^2\right] - s_i, \tag{3.6}$$

$$l^2_{(N-1)i} = \left(R + \frac{r_i + r_j}{2}\right)^2 a_k + \left(R + \frac{r_i + r_j}{2}\right)(r_i - r_j) + \frac{l_k^2}{4} +$$
$$+\left(R + \frac{r_i + r_k}{2}\right)^2 a_j + \left(R + \frac{r_i + r_k}{2}\right)(r_i - r_k) + \frac{l_j^2}{4} + \left(l_i^2 - l_j^2 - l_k^2\right)\left[\left(R + \frac{r_i + r_j}{2}\right)\frac{r_i - r_j}{l_k^2} + \frac{1}{2}\right]\left[\left(R + \frac{r_i + r_k}{2}\right)\frac{r_i - r_k}{l_j^2} + \frac{1}{2}\right],$$

$$l^2_{(N-1)i} = \lambda_i R^2 + \mu_i R + \nu_i, \tag{3.7}$$

$$\frac{d}{dR}l^2_{(N-1)i}=2\lambda_i R+\mu_i\,,\quad \frac{d^2}{dR^2}l^2_{(N-1)i}=2\lambda_i\,,\qquad \frac{1}{4}l_j^2=\frac{1}{4}(r_i-r_k)^2+s_j\,,$$

$$\lambda_i=a_k+a_j+(l_i^2-l_j^2-l_k^2)\frac{r_i-r_j}{l_k^2}\frac{r_i-r_k}{l_j^2}\,,$$

$$\mu_i=(r_i+r_j)a_k+(r_i+r_k)a_j+2r_i-r_j-r_k+\frac{l_i^2-l_j^2-l_k^2}{2}\left[\frac{r_i-r_j}{l_k^2}\left(\frac{r_i^2-r_k^2}{l_j^2}+1\right)+\frac{r_i-r_k}{l_j^2}\left(\frac{r_i^2-r_j^2}{l_k^2}+1\right)\right],$$

$$\nu_i=\frac{a_k}{4}(r_i+r_j)^2+\frac{a_j}{4}(r_i+r_k)^2+\frac{r_i^2-r_j^2}{2}+\frac{r_i^2-r_k^2}{2}+\frac{l_i^2}{4}+\frac{l_i^2-l_j^2-l_k^2}{4}\left[\frac{(r_i^2-r_j^2)}{l_k^2}\frac{(r_i^2-r_k^2)}{l_j^2}+\frac{r_i^2-r_k^2}{l_j^2}+\frac{r_i^2-r_j^2}{l_k^2}\right].$$

Right sides of (3.5)-(3.7) are quadratic in variable $R=c_N t$. The right-hand side of formula (3.3) with $n=N-1$ is a function of *R*, only asymptotically quadratic:

$$R^2_{(N-2)k}=\frac{1}{2}\left(R^2_{(N-1)i}+R^2_{(N-1)j}\right)-\frac{1}{4l^2_{(N-1)k}}\left(R^2_{(N-1)i}-R^2_{(N-1)j}\right)^2-\frac{1}{4}l^2_{(N-1)k}=$$

$$=\left(1-\frac{a_i+a_j}{2}-\frac{\lambda_k}{4}\right)R^2+\left[\frac{1-a_i}{2}(r_j+r_k)+\frac{1-a_j}{2}(r_i+r_k)-\frac{\mu_k}{4}\right]R+$$

$$+\frac{1-a_i}{8}(r_j+r_k)^2+\frac{1-a_j}{8}(r_i+r_k)^2-\frac{s_i+s_j}{2}-\frac{\nu_k}{4}-\frac{1}{\lambda_k R^2+\mu_k R+\nu_k}D^2_{(N-1)ij}(R)\,, \tag{3.8}$$

$$D_{(N-1)ij}(R)=\frac{R^2_{(N-1)i}-R^2_{(N-1)j}}{2}=\frac{a_j-a_i}{2}R^2+\left(\frac{r_j-r_i}{2}+\frac{r_i+r_k}{2}a_j-\frac{r_j+r_k}{2}a_i\right)R+$$

$$+\frac{1-a_i}{8}(r_j+r_k)^2-\frac{1-a_j}{8}(r_i+r_k)^2+\frac{s_j-s_i}{2}\,. \tag{3.9}$$

Derivatives of (3.6-3.8) in *R* are of the form: $\frac{d}{dR}R^2_{(N-1)i}=(1-a_i)(2R+r_j+r_k)$,

$$\frac{d}{dR}D_{(N-1)ij}(R)=D'_{(N-1)ij}(R)=(a_j-a_i)R+\frac{r_i+r_k}{2}a_j-\frac{r_j+r_k}{2}a_i+\frac{r_j-r_i}{2}\,,$$

$$l^2_{(N-1)k}=\lambda_k R^2+\mu_k R+\nu_k\,,\quad \frac{d}{dR}l^2_{(N-1)i}=2\lambda_i R+\mu_i\,,\quad \frac{d^2}{dR^2}l^2_{(N-1)i}=2\lambda_i\,,$$

$$\frac{d}{dR}R^2_{(N-2)k}(R)=\left(2-a_i-a_j-\frac{\lambda_k}{2}\right)R-\frac{\mu_k}{4}+\frac{1-a_i}{2}(r_j+r_k)+\frac{1-a_j}{2}(r_i+r_k)+$$

$$+\left[r_i-r_j-a_j(2R+r_i+r_k)+a_i(2R+r_j+r_k)\right]\frac{D_{(N-1)ij}(R)}{\lambda_k R^2+\mu_k R+\nu_k}+(2\lambda_k R+\mu_k)\left(\frac{D_{(N-1)ij}(R)}{\lambda_k R^2+\mu_k R+\nu_k}\right)^2, \tag{3.10}$$

$$\frac{d^2}{dR^2}R^2_{(N-2)k}=2-a_i-a_j-\frac{\lambda_k}{2}-2\frac{(a_j-a_i)D_{(N-1)ij}+\left(D'_{(N-1)ij}\right)^2}{\lambda_k R^2+\mu_k R+\nu_k}+$$

$$+\left[\lambda_k D_{(N-1)ij}+2(2\lambda_k R+\mu_k)D'_{(N-1)ij}-\frac{(2\lambda_k R+\mu_k)^2 D_{(N-1)ij}}{\lambda_k R^2+\mu_k R+\nu_k}\right]\frac{2D_{(N-1)ij}}{(\lambda_k R^2+\mu_k R+\nu_k)^2}\,.$$

From the formula (3.3), we find that the deceleration parameter of expansion of i-th $(N-2)$-dimensional sphere in $(N+1)$-dimensional space is:

$$-\frac{R_{(N-2)i}}{\dot R^2_{(N-2)i}}\ddot R_{(N-2)i}=1-\frac{2R^2_{(N-2)i}}{\left[\frac{d}{dR}R^2_{(N-2)i}\right]^2}\frac{d^2}{dR^2}R^2_{(N-2)i}=\frac{d}{dR}\left[\frac{2R^2_{(N-2)i}}{\frac{d}{dR}[R^2_{(N-2)i}]}\right]-1\,. \tag{3.11}$$

Here, $R=c_N t$, t is the cosmological time elapsed since the intersection of the 3D spheres at one point. Further restrict ourselves to the case $N=5$ of the expansion of 5D spheres in the 6D space with the same constant speed c_5.

From (3.11) and when $i=2$ and $R=c_5 t$ we find the deceleration parameter of expansion of the 3D sphere of primary interest for comparison of observations: $q_0=-R_{32}\ddot{R}_{32}/\dot{R}_{32}^2$ that equals 0.038 – the value obtained in [26] by the method of EMN (Evrard, Metzler, Navarro), not associated with Hubble constant.

Finding the parameters of the theory under which the results with acceptable accuracy would accord with observations, it is convenient to take place in two stages. At the first stage we put $R_{3i}^2(R')$ approximately quadratic function in the variable R' actually being only asymptotically quadratic in R'. In this approximation in the theory will be only two independent parameters. In the second stage it is expected to clarify the parameters of the theory.

In the simplest scenario, the value of the speed of light and elementary particles c_6 in the six-dimensional space is constant over time in the reference frame associated with the center of the three-dimensional sphere. Restrict ourselves to this case.

4. Increasing the speed of light in an expanding universe

All directions on the 3D sphere at any point are perpendicular to the direction of expansion of the sphere. Therefore, the speed of light $c_i(R')$ on this sphere and the speed of its radial expanding $\frac{dR_3(R')}{dt}=\frac{dR_3(R')}{dR'}c_5$ are connected by Pythagorean theorem: $c_i^2(R')+\left(\frac{dR_{3i}(R')}{dR'}\right)^2 c_5^2=c_6^2=const$, R' is the difference of the current radius of a 5D sphere, and its value at the time of the first crossing of the three spheres. Thus the equality $R'=c_5 t$ introduces the cosmological time, measured from the moment of the first intersection of the three 5D spheres, with today's value $c_i(R)$ for a suitable index *i* is the observed velocity of light c. The speed of light in 3D universe depends on radii of 5D spheres. However, being a real quantity, it satisfies the Pythagorean theorem only if

$$c_i(R')=\operatorname{Re}\sqrt{c_6^2-\left(\frac{dR_{3i}(R')}{dR'}\right)^2 c_5^2}\ . \qquad (4.1)$$

Given that $\frac{dR_{3i}(R')}{dR'}=\frac{1}{2R_{3i}(R')}\frac{dR_{3i}^2(R')}{dR'}$, here we obtain

$$c_i(R')=c_5\operatorname{Re}\sqrt{\frac{c_6^2}{c_5^2}-\frac{1}{4R_{3i}^2(R')}\left(\frac{dR_{3i}^2(R')}{dR'}\right)^2}, \qquad (4.2)$$

where for *i* = 2 $c_5=c\Big/\sqrt{\frac{c_6^2}{c_5^2}-\frac{1}{4R_{32}^2(R)}\left(\frac{dR_{32}^2(R)}{dR}\right)^2}$, $c_2(R)=c$ is the speed of light today.

By the definition of the Hubble constant, we have

$H_0=\frac{\dot{R}_{32}(R)}{R_{32}(R)}=c_5\frac{dR_{32}(R)}{dR}\Big/R_{32}(R)$, from this and (4.1) we obtain

$$H_0 t=\frac{R}{R_{32}(R)}\frac{d}{dR}R_{32}(R)=\frac{R}{2R_{32}^2(R)}\frac{d}{dR}R_{32}^2(R)=0.875\ , \qquad (4.3)$$

$$\sqrt{\frac{c_6^2}{c^2}-1}=\frac{c_5}{c}\frac{dR_{32}(R)}{dR}=\frac{H_0}{c}R_{32}(R), \qquad \sqrt{\frac{c_6^2}{c_5^2}-\frac{c^2}{c_5^2}}=\frac{dR_{32}(R)}{dR}.$$

Numerical calculations were performed for the following choice of parameters of the theory: $r_1/R=0.115$, $r_2/R=0.179$, $r_3/R=0.278$, $\beta_1=1.94$, $\beta_2=1.85$. In this $H_0 t=0.875$, $\frac{R_{32}(R)}{R}=1.104$. In [24] it is obtained that $\frac{c_6^2}{c_5^2}=\left(1+\frac{1}{q}\right)A$, where $q=1.8$, A is the coefficient at R^2 in an approximate representation $R_{32}^2(R)\approx AR^2+2\rho R$. In the exact representation (3.8) $A=1-\frac{a_1+a_3}{2}-\frac{\lambda_2}{4}$, $\frac{c_6^2}{c_5^2}=\left(1+\frac{1}{q}\right)\left(1-\frac{a_1+a_3}{2}-\frac{\lambda_2}{4}\right)$, $\frac{c_5}{c}=1.481$, $\frac{c_6}{c}=1.746$,

$$\frac{H_0}{c}R_{32}(R)=\sqrt{\frac{c_6^2}{c^2}-1}=1.431\,. \qquad (4.4)$$

The speed of light is no longer a zero and begins to grow from the time for which $\frac{1}{4R_{32}^2(\overline{R})}\left(\frac{dR_{32}^2(\overline{R})}{d\overline{R}}\right)^2=\frac{c_6^2}{c_5^2}$, $c_2(\overline{R})=0$. Value $\overline{R}$ is determined by parameters of the theory.

Relationship between the cosmological time $t(R')=R'/c_5$ and the time by Einstein's light clock $t_e(R')$ (the indices *i*, *j*, *k* later in inessential cases omitted) is defined by (3.13), $cdt_e=c(R')dt$ and $dt=dR'/c_5$, whence it follows that

$cdt_e=c(R')\,dR'/c_5$, $\qquad t_e(R_*)=\frac{1}{c}\mathrm{Re}\int_{\overline{R}}^{R_*}\sqrt{\frac{c_6^2}{c_5^2}-\frac{1}{4R_{32}^2(R')}\left(\frac{dR_{32}^2(R')}{dR'}\right)^2}\,dR'$, and the passage of light to the light hours of the astronomical object under consideration to the observer is equal to $T_e(R_*)=\frac{1}{c}\int_{R_*}^{R}\sqrt{\frac{c_6^2}{c_5^2}-\frac{1}{4R_{32}^2(R')}\left(\frac{dR_{32}^2(R')}{dR'}\right)^2}\,dR'$, $R_*>\overline{R}$. Here and below, respectively, the value is marked with an asterisk in a place of radiation.

Light clock starts ticking from the moment when the speed of light becomes different from zero, *i.e.* when $R_*>\overline{R}$. When $R_*<\overline{R}$ $t_e(R_*)\equiv 0$, so look back over time $T_e(\overline{R})$, the light clock opportunities do not give. Even greater restriction on the range of observation establishes the requirement that the redshift is finite and positive. It is violated when the observed object is removed with velocity greater than the speed of light. Thus, the age of the universe is equal to $T_e(\overline{R})$ by the light clock. Same cosmological age of the universe, if it is measured from the intersection of the three 5D spheres at one point is equal to $t=\frac{R}{c_5}=\frac{R}{c}\sqrt{\frac{c_6^2}{c_5^2}-\frac{1}{4R_{32}^2(R)}\left(\frac{dR_{32}^2(R)}{dR}\right)^2}$, where $R_{32}(R)$ is the radius of the 3D sphere today.

5. Redshift in an expanding universe

Beam of light came out of a point of the expanding 3D sphere and describes helix unwinding in a plane passing through the center of the sphere, the point of the source and the observation point. In this way $d\varsigma$ a photon is rotated in said plane at an angle

$$-d\chi=d\varsigma/R_3\,. \qquad (5.1)$$

The angle between the point source and the observation point, drawn from the center 3D sphere is

$$\chi_*=\chi(R_*)=\int_{t_*}^{t}\left[c(R')/R_3(R')\right]dt'=\frac{1}{c_5}\int_{R_*}^{R}\left[c(R')/R_3(R')\right]dR'\,. \qquad (5.2)$$

According to (4.2), it reduces to

$$\chi(R_*)=\int_{R_*}^{R}\frac{1}{R_3(R')}\sqrt{\frac{c_6^2}{c_5^2}-\frac{1}{4R_3^2(R')}\left(\frac{dR_3^2(R')}{dR'}\right)^2}\,dR'\,. \qquad (5.3)$$

In this

$$\frac{d}{dR'}\chi(R')=-\frac{1}{R_3(R')}\sqrt{\frac{c_6^2}{c_5^2}-\frac{1}{4R_3^2(R')}\left(\frac{dR_3^2(R')}{dR'}\right)^2} \qquad (5.4)$$

Distance on the three-dimensional sphere of radius R_3 from its pole to the point with the angular coordinate χ is χR_3. Let the observer at the pole, and at any point of the 3D sphere with a fixed angular position χ_* of light source. When extending the 3D sphere removal rate of the source from the observer on it is proportional to this removal (Hubble's law) and is $v=\chi_*\dot{R}_3(R)=s\dot{R}_3(R)/R_3(R)=sH_0$ where $s=R_3(R)\chi_*$. However, the observer sees the light source not there where this source there is (3D sphere of radius $R_3(R)$), and not such as this source is at the time of observation, but where this source was (in a 3D sphere of radius $R_3(R_*)$) and such as this source was at the time of radiation.

From (5.3) it follows that the light from a source away from the observer at a fixed angular distance in this plane passes through the expanding 3D sphere path $\varsigma(\chi_*)=\int_0^{\chi_*} R_3 d\chi$. From this and (5.4) we have $\varsigma=-\int\limits_{R_*}^{R} R_3(R')\dfrac{d\chi(R')}{dR'}dR'=\int\limits_{R_*}^{R}\sqrt{\dfrac{c_6^2}{c_5^2}-\dfrac{1}{4R_3^2(R')}\left(\dfrac{dR_3^2(R')}{dR}\right)^2}\,dR'$.

When $R-R_* << R$ (5.2) follows $\chi_*=\dfrac{c}{c_5}\dfrac{R-R_*}{R_3}$,

$$\varsigma=\chi_* R_3=\frac{c}{c_5}(R-R_*). \tag{5.5}$$

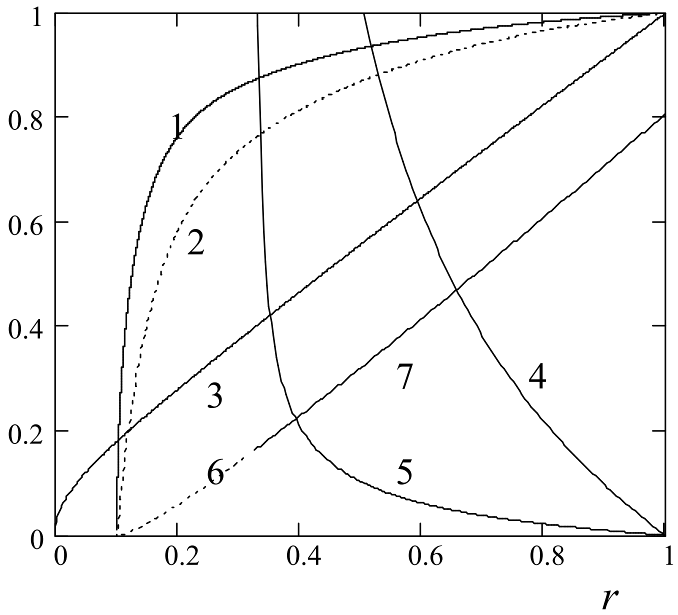


Figure 6: Depending on $r=R_*/R$, the relative cosmological time.
1 – the relative velocity of light,
2 – its square,
3 – the relative radius of 3D sphere,
4 – redshift $z(r)$, 5 – $z(r)/10$, 6 – relative time by the light clock, 7 – the same closer then the particle horizon.

Removal rate of the source from the observer $u=\dot{\varsigma}$ according to (5.3) and (5.4) is equal to

$$u(R_*)=\int\limits_0^{\chi(R_*)}\dot{R}_3 d\chi=\int\limits_{R_{3*}}^{R_3}\frac{d\chi}{dt}dR_3=\int\limits_{R_{3*}}^{R_3}\frac{c(R_3)}{R_3}dR_3=$$

$$=c_5\,\mathrm{Re}\int\limits_{R_*}^{R}\frac{1}{2R_3^2(R')}\sqrt{\frac{c_6^2}{c_5^2}-\frac{1}{4R_3^2(R')}\left(\frac{dR_3^2(R')}{dR'}\right)^2}\,\frac{dR_3^2(R')}{dR'}dR'. \tag{5.6}$$

$$\frac{u(R_*)}{c(R_*)}=\frac{\mathrm{Re}\int\limits_{R_*}^{R}\frac{1}{2R_3^2(R')}\sqrt{\frac{c_6^2}{c_5^2}-\frac{1}{4R_3^2(R')}\left(\frac{dR_3^2(R')}{dR'}\right)^2}\,\frac{dR_3^2(R')}{dR'}dR'}{\sqrt{\frac{c_6^2}{c_5^2}-\frac{1}{4R_3^2(R_*)}\left(\frac{dR_3^2(R_*)}{dR_*}\right)^2}}. \tag{5.7}$$

Whence, for $R-R_* << R$ we obtain

$$\frac{u(R_*)}{c(R_*)}\approx\frac{1}{2}\ln\left[\frac{R_3^2(R)}{R_3^2(R_*)}\right]\approx\frac{1}{2}\left[\frac{R_3^2(R)}{R_3^2(R_*)}-1\right]. \tag{5.8}$$

Redshift due to the Doppler' effect only (we denote z_d while leaving the standard notation z for the cosmology of magnitude), satisfies $u(R_*)/c(R_*)=\left[(1+z_d)^2-1\right]/\left[(1+z_d)^2+1\right]$ [12], which implies

$$(1+z_d)^2+1=\frac{2}{1-[u(R_*)/c(R_*)]}, \qquad 1+z_d=\sqrt{\frac{2}{1-[u(R_*)/c(R_*)]}-1}, \tag{5.9}$$

And when $R-R_*<<R$ we have

$$z_d\approx\frac{u(R_*)}{c(R_*)}\approx\frac{1}{2}\ln\frac{R_3^2(R)}{R_3^2(R_*)}\approx\frac{1}{2}\left[1-\frac{R_3^2(R_*)}{R_3^2(R)}\right]\approx 1-\frac{R_3(R_*)}{R_3(R)}. \tag{5.10}$$

According to (5.5) and (5.10) the distance ς is expressed through the Hubble constant H_0: $\frac{\varsigma}{R}=\frac{c}{H_0 R}z(R_*)=\frac{c}{H_0 R}\left[1-\frac{R_3(R_*)}{R_3(R)}\right]=\frac{c}{c_5}\left(1-\frac{R_*}{R}\right)$, where $z<<1$.

Fig. 6 shows, depending on $r=R_*/R$, the relative cosmological time: the relative velocity of light $c_2(Rr)/c_2(R)$ (curve 1), 2 − the square of it, 3 − relative radius $R_{32}(Rr)/R_{32}(R)$ of the 3D sphere, 4 − redshift z, 5 − $z(r)/10$, 6 − the relative time $t_e(Rr)/t$ by the light clock (on the dotted portion of the curve 6 object of observation is hidden from the observation), 7 – the same closer then the particle horizon.

The energy of each elementary particle, including photons, increases in proportion to the square of the speed of light. This effect is due to the constancy of the total energy of elementary particles in the 6D space and slowing expansion of the three-dimensional sphere. Thus the energy of a photon in the time of arrival at the observation point, taking into account the cosmological expansion of three-dimensional sphere will be equal to

$$h\nu=(c/c_*)^2 h_*\nu_*/(1+z_d), \tag{5.11}$$

where ν_* is the frequency of the radiation and h_* is Planck's constant near the source from the point of view of a distant observer, $c_*=c(R_*)$. In observational cosmology redshift z determined from the relation

$$\nu=\nu_{lab}/(1+z) \tag{5.12}$$

between registered frequency ν of characteristic radiation and respective frequency radiation ν_{lab} received in the laboratory. From (5.11) and (5.12) it follows

$$(c/c_*)^2 h_*\nu_*/(1+z_d)=h\nu_{lab}/(1+z). \tag{5.13}$$

For frequencies characteristic radiation of a hydrogen atom in the transition of an electron with the m-th energy level to the n-th, we have $\nu_{lab}=[s(m)-s(n)]m_e c^2/h$, $\nu_*=[s_*(m)-s_*(n)]m_e c_*^2/h_*$, where $s(m)=\sqrt{1-(Z\alpha/m)^2}$, $s_*(m)=\sqrt{1-(Z\alpha_*/m)^2}$, Z is the atomic number of the nucleus of the atom, m_e is the electron mass, $\alpha=e^2/\hbar c$ is the fine structure constant. From (5.10), (5.13) we find $1+z=(1+z_d)\frac{s(m)-s(n)}{s_*(m)-s_*(n)}$. It follows that if the fine structure constant does not change over time, and this with great accuracy confirmed by observations, then $z_d=z$, that more and accepted.

6. Radiation power density and brightness of cosmological distant source

For the power density U_* of the radiation source as a black body, given that according to Planck emissivity of the black body independent of the speed of light U_* in the radiation spot, we have [13, 27-31] at the temperature T_* of the radiating surface and a distant point of view of the observer:

$$U_*=\int_0^\infty 2\pi\nu_*^3\frac{h_*}{c_*^2}\left[\exp(h_*\nu_*/kT_*)-1\right]^{-1}d\nu_*=\pi^5\frac{2}{15c_*^2h_*^3}(kT_*)^4, \tag{6.1}$$

where k is the Boltzmann constant. Power stellar radiation of a star as blackbody is $4\pi a^2U_*=4\pi a^2\frac{2\pi^5}{15c_*^2h_*^3}(kT_*)^4$, where a is its radius. Light is distributed over the surface of the two-dimensional sphere of radius $R_{32}(R)\sin\chi_*$, and because of the increase in the speed of light towards the observer photon energy increases in c^2/c_*^2 time, and the Doppler-effect due to the expansion of the universe decreases in $1+z$ time. With increasing speed of light, not only increases the velocity of particles along helical trajectories, but also the projection of the velocity, in the same proportion. Therefore, the temperature being proportional to the mean square of the velocity of the Brownian motion of the particles is proportional to c_*^2. Whence we have $T_* = T(c_*/c)^2$, where T is the temperature of the radiating surface of the same source at cosmologically close distance. As well, according to the principle of equal basic properties of substance and light, the energy of a photon $h_*\nu_*$ is also proportional to c_*^2.The frequency of the radiation ν_* is proportional to c_* as well. From this it follows

$$h_* = h\,c_*/c\,, \qquad \nu_* = \nu_{lab}\,c_*/c\,, \tag{6.2}$$

so that the intensity of light produced by this star near the observer equals

$$S = \pi^5 \frac{2}{15c^2h^3}(kT)^4 \frac{a^2\sqrt{1-(u_*/c_*)^2}}{[R_{32}(R)\sin\chi_*]^2[1+z(R_*)]}\frac{c_*}{c}.$$

If the power density to determine a radiation energy per unit area and per unit time by light clock, given the ratio $cdt_e = c_*dt$, this intensity is equal to

$$S_e = \frac{L\sqrt{1-(u_*/c_*)^2}}{4\pi[R_{32}(R)\sin\chi_*]^2[1+z(R_*)]}\left(\frac{c_*}{c}\right)^2 = \frac{(c_*/c)^2}{[1+z(R_*)]^2+1}\frac{L}{[R_{32}(R)\sin\chi_*]^2 2\pi}, \tag{6.3}$$

where $L = \pi^5 \frac{2}{15c^2h^3}(kT)^4 4\pi a^2$ is the luminosity of the same source at cosmologically close distance. Here, $4\pi(R_{32}(R)\sin\chi_*)^2$ is the surface area of a sphere over which flowed radiation at the time of observation; $(1+z)^{-1}$ accounts for the decrease of the photon energy due to the Doppler effect, $\sqrt{1-(u_*/c_*)^2}$ accounts for the decrease of the number of photons due to time dilation in the source system, the factor $(c/c_*)^2$ in (5.11) describes the relative increase in energy of the photon due to increasing the speed of light during the journey. In this $\sqrt{1-(u_*/c_*)^2} = \frac{2[1+z(R_*)]}{[1+z(R_*)]^2+1}$.

And (6.2) also implies (5.13). Since $\pi^5 \frac{2}{15c_*^2h_*^3}(kT_*)^4 4\pi a^2 = L\frac{c_*^3}{c^3}$, the luminosity of the distant source L_* is less luminosity L: $L_* = (c_*/c)^3 L$. If the luminosity L_{e*} is defined as the radiation energy per unit time for light clock, then $L_{e*} = (c_*/c)^4 L$.

From (6.2) and constant over time the fine structure constant $\alpha_* = e_*^2/h_*c_*$, it follows that the charge is proportional to the speed of light: $e_* = e\,c_*/c$. Substituting (6.2) into (5.11) gives $\nu = \nu_{lab}/(1+z_d)$, a comparison of which with the formula (5.13) again leads to the result $z_d = z$. At $z = 1.7$ (for SN1997ff) $(c/c_*)^4 = 1.456$. From this and (6.4) shows that the lack of brightness of distant cosmological sources explained by an increase in the speed of light over time [23, 24], so that in the distant cosmological past corresponding to large z the speed of light was smaller. For the most distant supernovae discovered from $z = 1.914$, $L/L_{e*} = (c/c_*)^4 = 1.486$. Note that since the gravitational constant and the temperature is proportional to c_*^2, the force of gravity in deep space, *ceteris paribus* is smaller, it is balanced by the smaller pressure gradient within the star.

Note that in the formulas of the standard cosmology, the received intensity is generally assumed inversely proportional to $(1+z)^2$: Doppler-effect weakens it in $1+z$ time and in the same time it is considered weakened by reducing the frequency of arrival of photons to the observer [13]. Disagreement with this expressed in [27-30], where reduction in intensity is accounted by the factor $(1+z)^{-1}$, and not $(1+z)^{-2}$, so that reducing the frequency of arrival of photons to the observer not taken into account. In formula (6.3), a decrease in the number of photons due to time dilation in the source system described by the factor $\sqrt{1-(u_*/c_*)^2} = \frac{2}{1+z(R_*)+[1+z(R_*)]^{-1}}$. At large z, it twice multiplier $(1+z)^{-1}$ used in the standard cosmology to account for reducing the frequency of arrival of photons to the observer. Fig. 7 is a function z weakly depending on the argument $M = -2.512\cdot\log[R_{32}^2(R)S_e/L]$ at large redshifts. So brightness of cosmological distant quasars weakly depend in z.

7. Metagalaxy as part of the expanding universe which is available to observations

Particles on the horizon $z=\infty$, $u(R_*)/c(R_*)=1$, $r=r_\infty$, $\chi=\chi_\infty$. The selected parameters of the theory we have $R_{32}(Rr_\infty)/R_{32}(R)=0.398$, $r_\infty=0.3258$, $\chi_\infty=0.595$, $\sin\chi_\infty=0.56$. Metagalaxy radius is equal to $R_{32}(R)\sin\chi_\infty$. Affordable to monitoring portion of the volume of the Universe is equal to

$$[2\chi_\infty-\sin(2\chi_\infty)]\frac{1}{2\pi}=\frac{2}{3\pi}\chi_\infty^3\left(1-\frac{1}{5}\chi_\infty^2+\cdots\right). \tag{7.1}$$

It is 4.2% of its total capacity of the Universe. History of the Universe when $r\le r_\infty$ is hidden from observation.

Expression (7.1) can be obtained as follows. Equation of 3D sphere of radius R_3 has Cartesian view $z_1^2+z_2^2+z_3^2+z_4^2=R_3^2$. Coordinate z_4 (as well as other location) varies in limits $-R_3\le z_4\le R_3$. Therefore, it can be expressed as $z_4=R_3\cos\theta$ so that at a fixed angle θ the equation reduces to the 2D sphere $z_1^2+z_2^2+z_3^2=R_3^2\sin^2\theta$. Its surface area is $4\pi R_3^2\sin^2\theta$. Integrating this area to range from zero to χ find the volume of the section of 3D sphere under consideration: $V(\chi)=\pi(2\chi-\sin2\chi)R_3^3=\frac{4\pi}{3}R_3^3\chi^3\left(1-\frac{1}{5}\chi^2+\cdots\right)$, $V(\pi)=2\pi^2R_3^3$, which implies (7.1). Full volume amount of Metagalaxy by the selected parameters is $V(\chi_\infty)=\pi(2\chi_\infty-\sin2\chi_\infty)R_3^3=2.943\cdot10^{11}$ cubic Mpc.

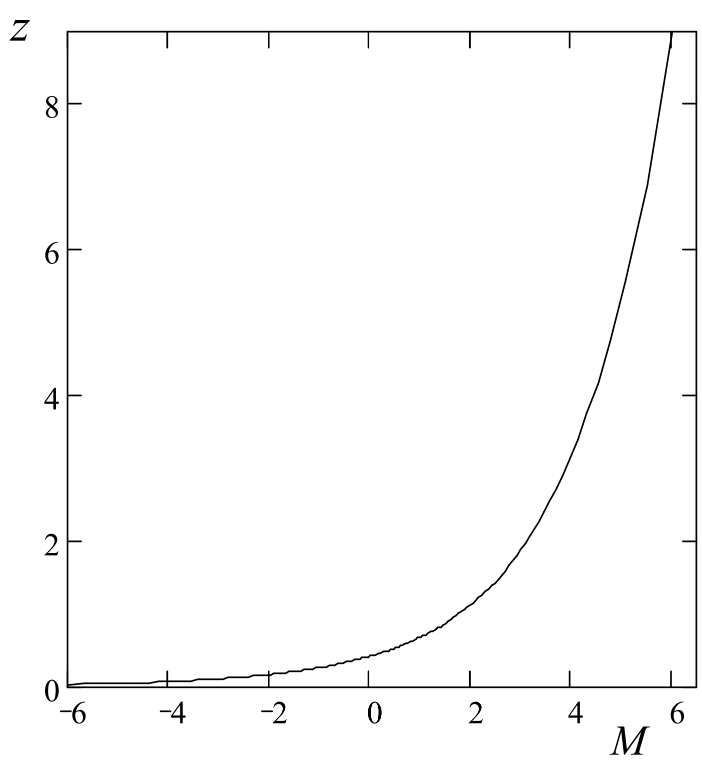


Figure 7: Dependence z on *M*. For large z the brightness of stars, quasars and galaxies is weakly dependent in z, since near the particles horizon small variations in distance from the source corresponds to a large range of changes in z.

8. The angular size of the distant double source

The angle subtended by a linear object − double radio source, removed by a distance corresponding to redshift $z(R')$ and 3D sphere radius $R_3(R')$ is equal to

$$\theta(R')=\frac{\ell c(R)}{c(R')R_3(R')\sin\chi(R')}, \tag{8.1}$$

where ℓ is the linear size of the object at cosmologically close distances. This relation follows from the fact that each beam is in its meridional plane passing through the source, the observation point and the center of the 3D sphere, and the angle between the meridian planes does not change with time. Double radio source components are gravitationally bound. Gravitational constant is proportional to the square of the speed of light, and the force of attraction between them is inversely proportional to the square of the distance between the components. The speed of light is decreasing with red shift increasing. Therefore, the distance between the components increases as the source is removed, and at sufficiently high z − faster than the distance to the source, which leads to an increase in the angular size of the double source for sufficiently large z. This factor, $c(R)/c(R')$, takes into account the right-hand side of equation (8.1). Thus, the curve $\theta(z)$ has a minimum that was observed experimentally by Kellermann and they specifically noted [10].

This experiment can be considered as an argument in favor of increasing the speed of light in time and as a way to more accurately determine the Hubble constant.

Right side of (8.1) with $z \ll 1$ and $\ell \ll \varsigma$ reduces to $\ell H_0/(cz)$ that does not depend on the parameters of the theory, which is useful for determining the Hubble constant from measurements $\theta(z)$ for the cosmologically close sources. If $\theta(R')$ present in the angular milliseconds, then in the case $\ell = 41$ pc right side of (8.1) must be multiplied by $41h216/(1000\pi)$. In this case the Hubble constant is determined from the condition that at small cosmological distances function $\ell H_0/(cz)$ is an asymptote for the function $\theta(z)$. With setting in the theory it will be $h = 0.604$. From this and (4.3), given that the $\dfrac{Mpc}{km/s} = 9.778 \times 10^{11}$ years, we find the age of the Universe 14.17×10^9 years by cosmological time and 11.44×10^9 years by the light clock and according to (4.4) we obtain $R_{32}(R) = 7103$ Mpc and $R = 6432$ Mpc. Radius accessible to observation of the Universe is equal to $R_{32}(R)\sin\chi_\infty = 3980$ Mpc.

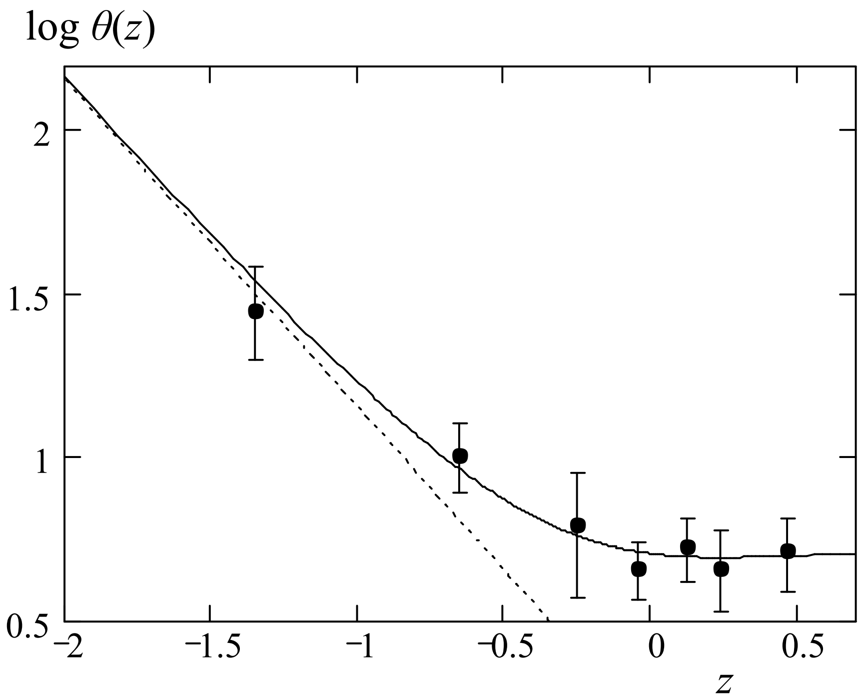


Figure 8: Dependence on z the angular size (in milliarcseconds) double source having at cosmologically close distances linear size of 41 pc.

In Fig. 8 double logarithmic function $\theta(z)$ is represented by the solid curve in the angular milliseconds using the relation (8.1) for $\ell = 41$ pc. With increasing z it tends to a constant non-zero value, which is consistent with the observed dependence of the angular dimensions of similar sources [10, 32] and because the particle horizon is at a finite distance from the observer on the line of sight. The dotted line shows the function $\ell H_0/(cz)$.

Only when $R_* > \bar{R}$, when the speed of light becomes nonzero, it become possible interactions between particles, and density inhomogeneities of the Universe begin to growth, followed by star formation. At this point, its relative radius reached a fairly large value of 0.18. For such a large radius of the Universe significant irregularities gravitational interaction is possible only within a relatively small area of the Universe, so that the evolution of inhomogeneities in each area is weakly linked with the evolution in the neighboring areas. Therefore, in large volumes, containing many such areas, the distribution of matter in space must be very uniform, and consistent with the observed distribution of galaxies. Starting growth inhomogeneities hidden from observation by particle horizon, so that on the horizon inhomogeneities may already be present in the form of stars. In [27-30], it is actually adopted.

9. Distribution of galaxies on redshift

With a uniform distribution of matter over three-dimensional sphere its amount in small angle range $d\chi$ is proportional to $\sin^2\chi\, d\chi$, the average number of galaxies in the range $d\chi$ is proportional to the same magnitude, if at the time of the observed light emission formation of galaxies is completed.

Relative density distribution of the number of sources on R_* and z are given by:

$n_r(R_*) = -\frac{4\pi}{N_\infty}\frac{d\chi(R_*)}{dR_*}\sin^2\chi(R_*)$, where according to (5.4) $\frac{d}{dR_*}\chi(R_*) = -\frac{1}{R_3(R_*)}\sqrt{\frac{c_6^2}{c_5^2} - \frac{1}{4R_3^2(R_*)}\left(\frac{dR_3^2(R_*)}{dR_*}\right)^2}$,

$n_r(R_*) = \sin^2\chi(R_*)\frac{4\pi}{N_\infty R_3(R_*)}\sqrt{\frac{c_6^2}{c_5^2} - \frac{1}{4R_3^2(R_*)}\left(\frac{dR_3^2(R_*)}{dR_*}\right)^2}$, $n_z(R_*) = n_r(R_*)\left[-\frac{dz(R_*)}{dR_*}\right]^{-1}$,

$$\frac{d}{dR_*}z(R_*) = \frac{1}{\left[1-\frac{u(R_*)}{c(R_*)}\right]\sqrt{1-\left[\frac{u(R_*)}{c(R_*)}\right]^2}}\frac{d}{dR_*}\left[\frac{u(R_*)}{c(R_*)}\right]$$

$$\frac{d}{dR_*}\left[\frac{u(R_*)}{c(R_*)}\right] = \frac{1}{2}\left[\frac{-W(R_*)}{4\left(c_6^2/c_5^2\right)R_3^2(R_*) - \left(dR_3^2(R_*)/dR_*\right)^2}\frac{u(R_*)}{c(R_*)} - \frac{1}{R_3^2(R_*)}\right]\frac{dR_3^2(R_*)}{dR_*},$$

$W(R_*) = \frac{\left(dR_3^2(R_*)/dR_*\right)^2}{R_3^2(R_*)} - 2\frac{d^2R_3^2(R_*)}{dR_*^2}$, $N_\infty = N(\infty)$ is the limit of the function $N(z) = 4\pi\int_0^\chi \sin^2\chi d\chi = \pi\{2\chi[r(z)] - \sin 2\chi[r(z)]\}$, $N_\infty = \pi[2\chi_\infty - \sin(2\chi_\infty)]$. When $R - R_* << R$,

$$\frac{u(R_*)}{c(R_*)} \approx \frac{1}{2}\ln\left[\frac{R_3^2(R)}{R_3^2(R_*)}\right] \approx \frac{1}{2}\left[\frac{R_3^2(R)}{R_3^2(R_*)} - 1\right].$$

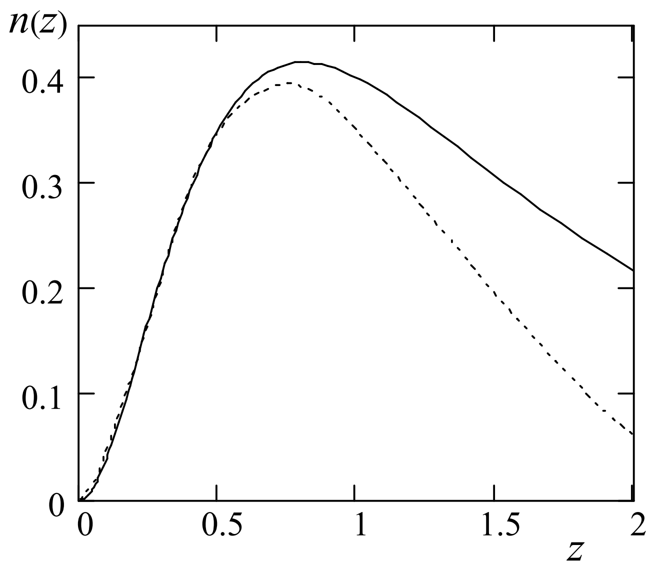


Figure 9a: Relative density distribution of number of galaxies at redshift z: calculated (solid line) and measured (dashed) [12].

Function $n(z)$ is shown in Fig. 9 by the solid curve. Dashed curve reproduced obtained from observations in the near infrared range density distribution on z of low-luminous galaxies tens of thousands [12], it is normalized so that the maxima of the two curves coincide. Steeper decline of the right branch of the curve at large z compared to the theoretical may be in the result a greater likelihood of shading sources by closer galaxies and dust clouds. If galaxies were distributed uniformly across the sky, then at each galaxy it would have a portion of the celestial sphere, roughly equal to one square arc second. The angular size of distant galaxies is approximately equal to one arc second, so that approximately half of the galaxies with large z are shaded by closer galaxies. However, there are no catalogs of galaxies with the same angular coordinates.

It is essential that $n(z)$ decreases as $(1+z)^{-3}$ with increasing z, decreasing, unlike the law $(1+z)^{-3/2}$ on the standard cosmology [13]. According to the observations of the two groups of researchers [15], the density distribution of quasars over z decreases as z^{-3} [34] or $(1+z)^{-2.75}$ [35].

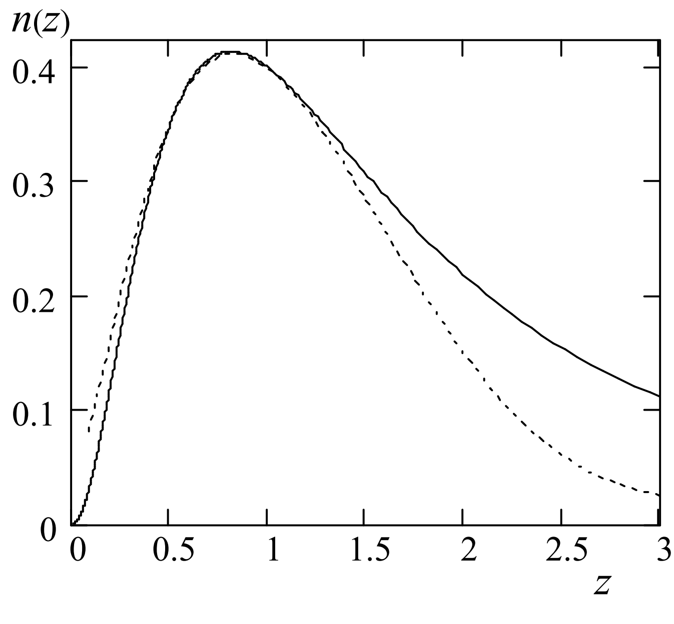


Figure 9b: The same theoretical curve in comparison with the later experimental curve [33].

Gamma-ray bursts are in galaxies, so they are evenly distributed over the 3D sphere with the same distribution function N. Obviously, for the same type of sources
$\log N = \log[2\chi - \sin 2\chi] + C_N$, where S is the recorded flow of energy, C_N and C_S are constant. In Fig. 10 for 1878 GRBs dependence of $\log N$ in $\log S$ is represented by the solid curve for $C_N = 3.74$ and $C_S = -5.36$. The dashed curve (here expressed in units of erg/cm^2) presents the observational data [36].

Shading of gamma-ray bursts is very little in comparison with the shading of galaxies even at large z. In Fig. 10 at large z shading of gamma-ray bursts is not observed.

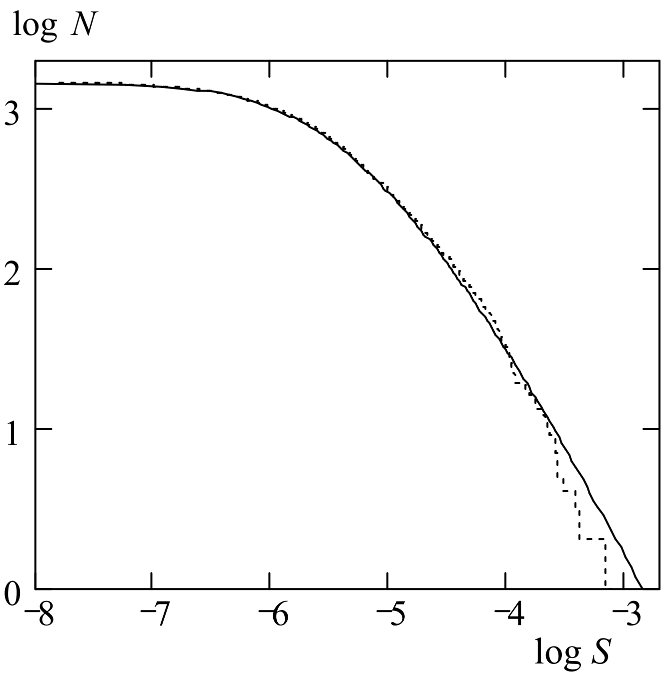


Figure 10 Logarithm of the distribution function of gamma-ray bursts as a function of the logarithm of the detected energy flux: calculated (solid line) and measured (dotted)

10. Increasing the speed of light and the energy flow into the universe as a consequence of slowing down of its expansion

Increase in kinetic energy of particles caused by an increase in the speed of light, as well as the increase in potential energy due to an increase in the gravitational constant, it would seem, is a clear violation of the law of conservation of energy. However, in the preparation of the energy balance in a multidimensional space is necessary to consider the energy of all kinds of movement, including the movement along a helical path placed on the Compton distance $a = \hbar/mc$ around the three-dimensional projection of the particle trajectory, as well as movement in the extra space caused by the expansion of three-dimensional universe. Total particle velocity in the six-dimensional space remains constant in magnitude, irrespective of the trajectory in three-dimensional space as well in whole space. Therefore, the law of conservation of energy in the whole space is not violated.

When slowing down the expansion of the universe, three-dimensional velocity of light increases while when accelerating expansion – decreases. Note that the relatively recent withdrawal of standard cosmology accelerated expansion of the Universe is made in the implicit assumption of the applicability of the Einstein equations to cosmology. In the six-dimensional interpretation of the expanding Universe, this assumption is not involved.

The growth speed of light is limited. But when the cosmological age of the Universe will double, speed of light squared increase by 0.061 of its current of magnitude. This corresponds with nothing comparable amount of energy that has yet to enter into the Universe, 6.1% of the current energy of all types, including the energy of particle motion with the speed of light at a specified helical line [1, 3-5]. Energy flow per unit time, which basically determines the observed rate of star formation in galaxies continuously throughout their history, is proportional to the magnitude

$$n_z(R_*)\frac{dc_k^2(R_*)}{dt_*}, \text{ where } \frac{dc_k^2(R_*)}{dt_*} = c_5\frac{dc_k^2(R_*)}{dR_*} = c_5^3\frac{W_k(R_*)}{4R_{3k}^2(R_*)}\frac{dR_{3k}^2(R_*)}{dR_*},$$

$$W_k(R_*) = \frac{\left(dR_{3k}^2(R_*)/dR_*\right)^2}{R_{3k}^2(R_*)} - 2\frac{d^2R_{3k}^2(R_*)}{dR_*^2}, \quad \frac{dc_k^2(R_*)}{cdt_e} = \frac{c}{c_*}\frac{dc_k^2(R_*)}{dt_*} = \frac{c}{c_*}c_5^3\frac{W_k(R_*)}{4R_{3k}^2(R_*)}\frac{dR_{3k}^2(R_*)}{dR_*},$$

$$\frac{dc_k^2(R_*)}{c^2H_0dt_*} = \frac{c_5^3}{c^3}\frac{cW_k(R_*)}{H_0R_{3k}^2(R_*)}\frac{dR_{3k}^2(R_*)}{4dR_*} = \frac{c_5^3}{c^3}\frac{W_k(R_*)R_{3k}(R)}{4R_{3k}^2(R_*)\sqrt{\left(c_6^2/c^2\right)-1}}\frac{dR_{3k}^2(R_*)}{dR_*},$$

$$\frac{d}{dR_*}R_{3k}^2(R_*) = \left(2 - a_i - a_j - \frac{\lambda_k}{2}\right)R_* - \frac{\mu_k}{4} + \frac{1-a_i}{2}(r_j + r_k) + \frac{1-a_j}{2}(r_i + r_k) +$$

$$+\left[r_i - r_j - a_j\left(2R_* + r_i + r_k\right) + a_i\left(2R_* + r_j + r_k\right)\right]\frac{D_{4ij}(R_*)}{\lambda_kR_*^2 + \mu_kR_* + \nu_k} + \left(2\lambda_kR_* + \mu_k\right)\left(\frac{D_{4ij}(R_*)}{\lambda_kR^2 + \mu_kR + \nu_k}\right)^2,$$

$$\frac{d^2}{dR^2}R_{3k}^2(R_*) = 2 - a_i - a_j - \frac{\lambda_k}{2} - 2\frac{(a_j - a_i)D_{4ij}(R_*) + \left(D'_{4ij}(R_*)\right)^2}{\lambda_kR_*^2 + \mu_kR_* + \nu_k} +$$

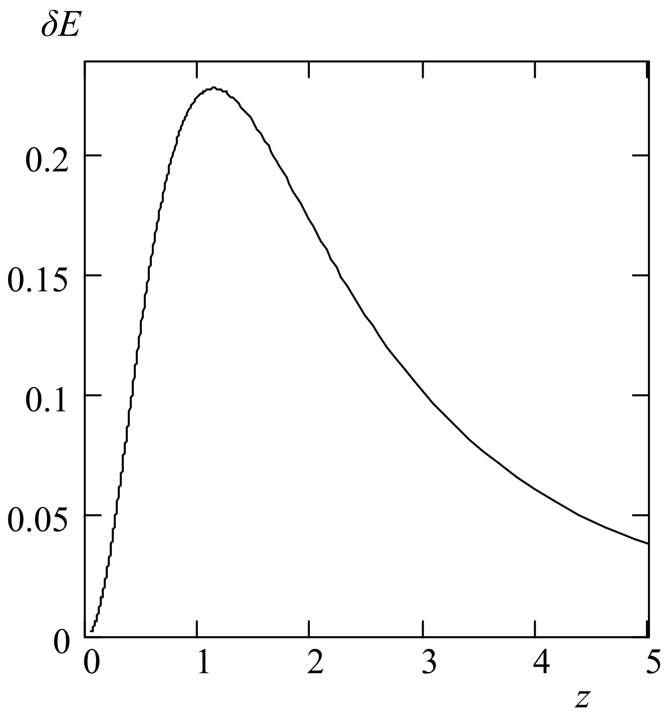
$$+\left[\lambda_k D_{4ij}(R_*)+2(2\lambda_k R_*+\mu_k)D'_{4ij}(R_*)-\frac{(2\lambda_k R_*+\mu_k)^2 D_{4ij}(R_*)}{\lambda_k R_*^2+\mu_k R_*+\nu_k}\right]\frac{2D_{4ij}}{(\lambda_k R_*^2+\mu_k R_*+\nu_k)^2},$$

$$D_{4ij}(R_*)=\frac{a_j-a_i}{2}R_*^2+\left(\frac{r_j-r_i}{2}+\frac{r_i+r_k}{2}a_j-\frac{r_j+r_k}{2}a_i\right)R_*+\frac{1-a_i}{8}(r_j+r_k)^2-\frac{1-a_j}{8}(r_i+r_k)^2+\frac{s_j-s_i}{2},$$

$$D'_{4ij}(R_*)=(a_j-a_i)R_*+\frac{r_i+r_k}{2}a_j-\frac{r_j+r_k}{2}a_i+\frac{r_j-r_i}{2}.$$

When the radius of the universe doubles, the energy flow will decrease 6.65 times. In an era when the radius was half the current, which corresponds to the red shift $z=1.53$, the flow was 4.2 times greater than the current one. Redshift $z=\infty$ corresponds to the relative value of the radius $R_{32}(Rr_\infty)/R_{32}(R)=0.398$ and the flow of energy in 6.34 times more than the current inflow. At even smaller radii, the inflow was much more: in the moment when he started, it was 95.6 times greater than the current one. At that moment, the radius of the Universe and its cosmological age were respectively 5.56 and 10 times less than the current, and only joined the light clock.

Density distribution in z of inflow of total energy in the Universe per unit time, including the proper energy of the particles $E=mc_*^2$, is proportional to the function $n\,dc_*^2/dt_e$. Its maximum is reached at $z=1.134$. According to [16], the maximum rate of star formation is observed at $z=1.1$.
Even earlier, it was found [15] that at the same redshift is observed maximum growth of metallicity of the intergalactic gas. This coincidence is natural, since the formation of stellar explosions and metals occurs, and the more energy flow in the stars, the more often they explode.



Function $\delta E=\left(n\,dc_*^2/dt_e\right)/H_0c^2$ depending on z as shown in Fig. 11, decreases with increasing z simply because the distribution density of the galaxies by z of this ratio decreases, although the flow of energy in each galaxy is increased.

Figure 11: $\delta E=n\dfrac{dc_*^2/dt_e}{H_0c^2}$

Fig. 6 shows that the values change $r=R_*/R$ and $t_e(Rr)$ attributable to a region of large redshift are relatively small. For such a small period of time a significant metallicity evolution of galaxies and other characteristics not happen in time. But from the moment $t_e(\overline{R})$ corresponding to the value of $r=\overline{R}/R=0.100$, from which the speed of light began to grow from zero to a time corresponding to $r=r_\infty=0.326$ and redshift $z=\infty$, it passed a lot of time: $t(Rr_\infty)-t(\overline{R})=0.226t(R)$ and $t_e(Rr_\infty)/t_e(R)=0.163/0.807=0.202$. That is, 22.6 and 20.2% of the age of the Universe, respectively, by the cosmological and light clocks. This time is sufficient for the formation of galaxies. Moreover, by the time the Universe has received 76% of the current energy.

Metagalaxy – observable part of a three-dimensional sphere – is expanding along with the three-dimensional sphere, though only from the time when the speed of light has ceased to be equal to zero. In the process of expanding, Metagalaxy covers all new and new volumes of space with galaxies formed at least sufficiently large cosmological time $t(Rr_\infty)$. Thus, to the observer's eye galaxies appear in his field of vision as really ready-made, though, of course, the formation of galaxies does not occur before the emergence of the Universe, but it occur for cosmological sufficiently long time after the speed of light has ceased to be equal to zero, and the Universe expanded to cosmologically large sizes.

The energy of motion of the particle $E = mc_*^2$ in the complementary subspace is proportional to c_*^2. Its increment per unit time is equal to $dE/dt_e = m\,dc_*^2/dt_e = E\varepsilon$, where, taking into account $cdt_e = c_* dt$,

$$\varepsilon(R_*) = \frac{c}{c_*^3}\frac{dc_*^2}{dt_e} = \frac{c}{c_* t}\frac{dR_{32}^2(R_*)}{dR_*}\frac{W_2(R_*)R}{4(c_6/c_5)^2 R_{32}^2(R_*) - \left(\frac{dR_{32}^2(R_*)}{dR_*}\right)^2}.$$

The same applies to the photon energy $h_*\nu_*$ and the kinetic energy, and hence the density U of the thermal energy. Therefore $dU/dt_e = \varepsilon U$. Thus, in unit volume per unit time it is inflated energy equal to εU. For the case when pumping occurs quasi-stationary, so that the energy radiating by surface of a star or planet is almost equal to the energy pumped, integrating over the volume of the celestial body of radius R_s, we obtain the relationship between ε and power density w of radiation by the surface of the body:

$$\varepsilon\int_0^{R_s} r'^2 U(r')dr' = R_s^2 w, \tag{10.1}$$

where r' is the distance from the center of a celestial body. Today $\varepsilon = 3.05\cdot 10^{-19}$ 1/s. In an age appropriate to $z=1$, ε there was more the current value in 4.15 times, at $z=2$ in 8.34 times, at $z=3$ in 7.36 times, at $z=\infty$ in 9.56 times.

With respect to thermal radiation of the Earth we have, according to (10.1) for the volume-averaged quantities:

$$U_1 R_1^3\,\varepsilon/3 = w_1 R_1^2, \quad \left[U_1 R_1^3 + U_2\left(R_s^3 - R_1^3\right)\right]\varepsilon/3 = wR_s^3,$$

where R_1 is the radius of the Earth's core, U_1 and U_2 are averaged respectively in terms of the core and shell of the Earth thermal energy density, w_1 is power density of the nucleus. Eliminating U_1 we obtain $w = \frac{\varepsilon}{3}R_s U_2 \frac{1-(R_1/R_s)^3}{1-(R_1/R_s)^2(w_1/w)}$ for $R_s = 6371$ km, $R_1/R_s = 0.531$, $\varepsilon = 3.05\cdot 10^{-19}$ 1/s. Light pressure in the shell of the Earth can be neglected. According to [37] $w_1/w = 13/27$, the heat capacity in the shell is 1.5 kal/cm^3, average temperature can be taken as 4500K. Thus $U_2 = 2.83\cdot 10^{10}$ J/m^3, $w = 16.8$ mW/m^2, which is 20% of the total density of the observed flux equal to 87 mW/m^2 [38]. Since the cosmological component of the geothermal heat decreases slower than release of energy due to radioactive decay, the share of cosmological radiation power from the Earth will increase.

For the Sun $R = 6.960\cdot 10^8$ m, the luminosity $3.846\cdot 10^{26}$ W, $w = 6.318\cdot 10^7$ W/m^2, $\overline{U} = 9.560\cdot 10^{17}$ J/m^3 = $2.283\cdot 10^{11}$ cal/cm^3. Temperature T corresponding to $\overline{U}$ we find from the equation $\overline{U} = \alpha_l T^4 + \frac{3\rho}{2\mu}R_g T$ [13], where μ is the molecular weight of the gas, $R_g = 8.3145$ J/cm^3 deg is the gas constant, $\alpha_l = \pi^2 k^4/\left(15\hbar^3 c^3\right)$; k, $\hbar$, c are fundamental constants. For the Sun, consisting mostly of hydrogen − a monatomic gas, the equation reduces to $\overline{U} = 17.56\cdot T + 7.566\cdot 10^{-22}\cdot T^4$ J/cm^3. Its solution $T = 5.96\cdot 10^6\,K$ is a typical temperature for the standard solar model [34].

Equation (10.1) by a known power density [39] allows us to estimate the average density of the thermal energy within the celestial bodies, if the radiated power is mainly due to an increase in the speed of light: $\overline{U} = 3w/\varepsilon R_s$. For the Moon $R = 1737$ km, $w = 2.2$ mW/m^2, density $\rho = 3.344$ g/cm^3, specific heat 0.3 cal/(g deg) = 1 cal/(cm3 deg). At the same time $\overline{U} = 1.245\cdot 10^{10}$ J/m^3 = 2974 cal/cm^3, average temperature $T = 2965$ K.

Range of luminosities of quasars is $L = 10^{38}\div 10^{40}$ W at radii of a few light-days. Assuming for the quasar $L = 10^{40}$ W and radius equal to one light day, $R = 2.59\cdot 10^{13}$ m, we obtain $w = 1.18\cdot 10^{12}$ W/m^2, $\overline{U} = 4.81\cdot 10^{17}$ J/m^3, so that the average energy density in quasars is of the order solar. This is evident from the formula $\overline{U} = L/\varepsilon$ for the total thermal energy in the quasi-steady energy pumping.

With the accumulation of power, massive star can not expand all the time quasi-stationary. With increasing radius of the star, photons travel from the center to the periphery (in the scattering medium) occupies more time. Because energy accumulating faster. When due to the increase luminosity L and thermal energy for slowly expanding of the star, the pressure gradient of light on its periphery exceeds the density of gravity force, and t L/ε he substance will be carried away from the stellar surface by light pressure. And the gradient of light pressure on the renewed periphery of the star grows in accordance with the higher temperature of its deeper layers, and then the star explodes as a supernova or new. Sparse in the explosion stellar matter again aggregates by gravitational forces, and the process of star formation in the universe continues until the square of the speed of light increases with time not too slow.

REFERENCES

1. Urusovskii IA. Lorentz Transform in Multi-Dimensional Space. Journal of Modern Physics, 2012; **3**(11): 1749-1756.
2. Margolin AA. The principle of simplicity. Khimiya i zhizn (Chemistry and Life). 1981; 9: 79-83. Russian.
3. Urusovskii IA. Six-dimensional interpretation of relativistic mechanics and spin, metric theory of gravitation and the expansion of the universe. Zarubezhnaya radioelectronika. Uspekhi soremennoi radioelectroniki. 1996; 3: 3-21. Russian.
4. Urusovskii IA. Six-dimensional interpretation of the quark model of nucleons. *ibid*., No. 6, 1999, pp. 64-74. Russian.
5. Urusovskii IA. Six-Dimensional Treatment of CPT-symmetry. Proceedings of International Scientific Meeting 'Physical Interpretations of Relativity Theory. Bauman Moscow State Technical University, Moscow: 4-7 July, 2005, 318-326. http://www.chronos.msu.ru/RREPORTS/urusovsky_six.pdf
6. Busarello G, Capozziello S, De Ritis R. Apparently periodic Universe. Astron. Astrophys. March 1994; **283**(3): 717-721.
7. Riess AG *et al*. A re-determination of the Hubble Contsant with the Hubble Space Telescope from a Differential Distance Ladder /arxive: 09.05.0695
8. Tammann AG. Confrontation of Cosmological Theories with Observational Data. IAU, Symposium No. 63 (Copernicus Symposium II) in Cracow, Poland, 10-12 Stptember, 1973.
9. Schwarzschild B. Farthest Supernova Strengthens Case for Accelerating Cosmic Expansion. Physics Today. June 2001; 17-18.
10. Kellermann KI. The Cosmological Deceleration Parameter Estimated from the Angular-Size/Redshift Relation for Compact Radio Sources. . 361(6408), 1993, 134-136.
11. Gurvits LI, Kellermann KI and Frey S. The angular "size – redshift" relation for compact radio structures in quasars and radio galaxies. Astronomy and astrophysics. 1999; **342**(2): 378-388.
12. Broadhurst TE, Ellis RS and Glasebrook KK. Faint Galaxies: Evolution and Cosmological Curvature. Nature. 1992; **355**(6355): 55-58.
13. Zel'dovich Ya. B. , Novikov ID. Structure and Evolution of the Universe. Nauka. Moscow, 1975. Russian.
14. Nagao T, Maiolino R, Marconi A. Metallicity Evolution of Active Galactic Nuclei. http://arxiv.org/astro-ph/0612570
15. Shaver PA. High Redshift Quasars. 17-*th* (1994) Texas Symposium on Relativistic Astrophysics and Cosmology. The New York Academy of Science. 1995; 87-109.
16. Tresse L *et al*. The cosmic star formation rate evolution from z = 0 to z = 5 from VIMOS VLT Deep Survey. http://arxiv.org/astro-ph/0609005.
17. Klein F.. Uber neuere englische Arbeiten zur Gesammelte matematishe Abhandlungen. B.2, Springer, Berlin, 1922: 601. Zeitschrift fűr Mathematik und Physik. 1901: 375.
18. Klein F. Vorlezungen über die höhere Geometrie. 3. Aufl. Berlin, 1926.
19. Rumer Yu. B., Investigations in 5-optics. Gostekhizdat: Moscow; 1956. Russian.
20. di Bartini RO. Doklady Akademy Nauk SSSR. 1965; **163**(4): 861-865. Russian.
21. Urusovskii IA. Gravity as a projection of the cosmological force. Proceedings of International Scientific Meeting PIRT-2003. Moscow, Liverpool, Sunderland. Bauman University, 30 June – 03 July 2003: 359-367. http://www.chronos.msu.ru/RREPORTS/urusovsky_gravity.pdf
22. Urusovskii IA Gravitational Waves and Papapetrou Metric in the Six-Dimensional Treatment of Gravitation. Physics of Wave Phenomena. Allerton Press, Inc. 2010; **18**(3): 185-195. doi:10.3103/S1541308X10030064
23. Urusovskii IA. Six-dimensional interpretation of the universe's expansion. Zarubezhnaja radioelectronika. Uspekhi soremennoi radioelectroniki. 2000; 6: 66-77. Russian.
24. Urusovskii IA. Stumbling blocks of standard cosmology in the light of six-dimensional cosmology. Hypercomplex Numbers in Geometry and Physics. 2007; 4(2): 146-66. Russian.
25. Landau LD and Lifshitz EM. Mechanics, Electrodynamics. Nauka; 1969. Russian.
26. Rines K, Forman W, Pen U, Jones C and Burg R. Constraining q_0 with cluster gas mass fractions. Feasibility study. Astrophysical Journal. May 20, 1999; **517** (1), Pt. 1: 70-77.
27. Troitsky VS and Aleshin VI. Observed Evidence of Microwave-Background Formation by Thermal Radiation of Metagalaxy Stars. Radio physics and Quantum Electronics. 1996; **39**(7) : 539-557.
28. Troitsky VS. Observational Test of the Cosmological Theory Testifies to the Static Universe and New Redshift-Distance Relation. Astrophysics and Space Journal. 1996; **240**(1): 89-12.
29. Troitsky VS and Gorbacheva VS. No dependence of the optical spectra of quasars from their redshift. Pis'ma v Astronom. Zh. (Letters in Astronomical Journal). 1993; **19**(3): 329-333. Russian.
30. Troitsky VS. Astrophysics Space Science. 1993 ; **201** : 89-121.
31. Levich VG. Course of Theoretical Physics. **1**. Nauka; 1969. Russian.
32. Ferguson HL, Williams RE and Cowie LL. Probing of Faintest Galaxies. Physics Today. April 1997: 24-30.

33. Glasebrook KK, Cole S and Ellis RS. The 2dF Galaxy Redshift Survey: spectra and redshifts. Monthly Notices of the Royal Astronomical Society. 2001; **328**: 1039-1063.
34. Schmidt M, Schneider DP and Gunn JE. In: Space Distribution of Quasars. Astronomical Society Pacific Conference Series. Ed. D. Crampton, 1991:109.
35. Möller P, Warren S. *ibid*: 96.
36. Kurt VG. Experimental methods for the study of cosmic gamma-ray bursts. Soros Educational Journal. 1998; 6:71-76. Russian.
37. Zharkov VN, Trubitcin VP, Samsonenko PV. Physics of the Earth and planets. Science: Moscow; 1983. Russian.
38. Stein CA. Heat Flow of the Earth. AGU Reference Shell 1. Global Earth Physics. Handbook of Physical Constants. Ed. T. J. Ahrens; 1995: 144-258.
39. Yoder CF. Astrometric and Geodetic Properties of the Earth and the Solar System. *ibid*., 1995: 1-13.