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ALTERNATIVE COSMOLOGY

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An alternative cosmological model (relative to the standard one) of the Universe is considered. The infinite Universe cannot exist and has to contract into a black hole due to the gravitational collapse. This fact shanges our representations about the Universe and explains its main properties, particularly – the non-singular initial point ("Big Bang") and irreversible expansion. In such the model Time is stricly proportional to the Universe radius, and the total energy and mass do not conserve, they increase due to some external ressource.

PREFACE

In this book I propose to English-speaking readers the new cosmological model. The model was developed since 1993 and is described in the Russian version of the book having the same name and also in a number of my separate publications on my web-site www.timeorigin21.narod.ru in both languages. Here I just collected these publications as the appendixes to the basic texts.

So far the above model has not any recognition in Russia. Particularly, the journal “Physics-Uspekhi” found that “these ideas do not correspond to modern scientific representations“, and the “Journal of Experimental and Theoretical Physics – JETP” wrote me that my paper is “purely methodical one”. It is amusingly to think that similar answer could be directed, for example, to Einstein or Dirac.

The single non-official organization that accepted friendly me and my model was the Russian Interdisciplinary Temporology Seminar with his Chairman Dr. Alexander P. Levich from MSU (1945 - 2016) to whom I am sincerely grateful for his maintenance. I also would like express my gratitude to my co-author Garry Raffel (USA).

The readers may send me questions and remarks using my e-mail: shulman@dol.ru .

Author, August of 2016

CONTENT

1. WHAT IS TIME?

The modern cosmology de-facto considers the Universe as a thermodynamically isolated system, and it supposes that its total energy and matter amount does not change over all its evolution time. However, Lee Smolin refers to J. A. Wheeler and wrote in [16]:

“It may then be conjectured that each black hole of our universe leads to such a creation of a new universe and that, correspondingly, the big bang in our past is the result of the formation of a black hole in another universe.”

What is Time? In the Newtonian epoch one can think about Time as some universal parameter that mystically increased anywhere in the Universe, and any physical process evolved with this Time. In Special Relativity (SR) some contraposition between Time and Space is partially overcame due to their unification in the 4D-continuum. However, in SR the temporal component seems to be “exotic” due to imaginary factor. General Relativity (GR) connects the Time features with gravitation fields and spatial geometry. Additionally, the Time currency is connected with the Universe expansion.

We can state that Time in a physical process can be specified by a *temporal* size (extent) as well as a *spatial* size. For example, a process may be specified by an oscillation period, (half) lifetime, etc. However, Time has the additional feature that Space does not have. The known Russian astrophysicist N.A. Kozyrev introduced the notion of the “Time rate” **[Kozyrev, 1991]**. Also one talks about different Time arrows (cosmological, thermodynamic, etc.) and a connection between them.

One can use different reasoning lines in order to understand the essence of Time. The first line is based on Time as some primordial notion that should not to be explained. The second line consists in the deduction of the Time notion from some other (microscopic) fundamental conceptions. However, the third way is also possible and presents the base of the proposed model: Does some *general* physical process in the Universe exists that could *generate* the universal physical Time?

Interestingly, such fundamental cosmological process really exists! Furthermore, it is well known in astrophysics. It is the Universe expansion recovered in the beginning of 20th century. There is not a single center inside of our Universe from which the expansion occurs. Simply all bodies in the Universe move away one from another.

My first reflections on cosmology (1993) were inspired by Kozyrev’s ideas. Initially I tried to imagine a purely spatial 4D Euclidian spherical Universe. The idea appeared: may be, it is possible to *identify the Time concept with the Universe radius*? Then we do not needed in some construction of Time notion and can explain its universality.

However, the conflict appears here with the GR cosmology. In the commonly accepted cosmological model the Universe radius dependence on its age is not at all a linear one! After a long enough reflection I saw this situation solution. The *standard* approach to solve the Einstein-Friedmann (EF) equations system presumes to set matter pressure P to zero (if one ignores the pressure of light). If one rejects this coercive identification, then the solution exists where radius *linearly* depends on Time. There a pressure turns out to be an unknown function which should be established as the solution result. Furthermore, the matter density also should not be now given by some external way, and its distribution turns out to be a quantity which is determined as the solution result.

All this was good, but two new problems were very embarrassing. Firstly, the revealed pressure turned out to be sufficiently *negative* one (and the Einstein’s authority seemed to be steadfast). Secondly, in the new model the energy conservation law wasn’t satisfied, and that seemed to be terrible too.

Some time ago I suddenly understood why the revealed pressure in fact *must* be negative. This pressure is simply a manifestation of the gravitational field volumetric energy, and the last really is specified by its tendency to contract a matter to a common center (not to recede like a gas particleы).

The energy and matter non-conservation in the Universe has the more intriguing explanation. The conservation law (which follows from the Noether's theorem) is due to the Time *uniformity*, i.e. the physics invariability during all the Universe history. However, in GR physics greatly depends on Universe geometry. Particularly, the fundamental metric tensor components (hence, gravitational force) depend on the Universe curvature radius. Because of that one cannot consider Time as uniform. It means that the conservation laws follow from space-time features and cannot be arbitrary given as some external conditions. For example, in classic mechanics the energy law conservation is true only if the Lagrange function does not depend explicitly on time, else it did not correspond to the conservation law.

The fact caused me to think that the situation is very similar to this one with a black hole (BH). The last regularly absorbs the matter from inside and irreversibly increases its mass and its size, i.e. expanses like our Universe. So, the mass and size specify the actual state of BH as well as the growth rings specify the wood age. One can use a BH size to define its own *parametric* time – this time *currents* only if the BH growths.

However, the question appears: can our Universe be a black hole? It was three stages on my road when I tried to answer this question. First stage – the horror caused by my impertinence, it is impossible because it leads to impossible consequences!

Meanwhile, the second stage came – I saw several publications where similar ideas appeared. Such, at the end of 2010 I found the paper **[Smolin, 1994]** where the conjecture of J. A. Wheeler was reproduced:

> "It may then be conjectured that each black hole of our universe leads to such a creation of a new universe and that, correspondingly, the big bang in our past is the result of the formation of a black hole in another universe".

Finally, after long investigations I revealed two pioneers of this idea, see **[Good, 1972]**, **[Pathria, 1972]**, and more details in Appendix 12 of this book.

Many years I tried to persuade scientific community to consider this hypothesis as one only of possible one. All was for nothing. However, I received the answer from another side. A simple but irrefutable proof based on several known facts transformed the problem into third stage – our Universe *can't not be* a black hole in some external world (see Section 2 of this book). And finally, in 2016 the prominent (as I believe) work **[Melia, 2016]** appeared in ArXive.org, where the results of the direct Universe expansion rate measurement was presented.

Note, as BH irreversibly increases its mass and event horizon area while "eating" external resources, it expands like our Universe. One can get many arguments in favor of such concept. Furthermore, this model can successfully compete with the Standard Cosmological Model (SCM).

But our Universe seems to be isotropic, and BH theory considers them as very non-isotropic. If for an *external* observer a typical BH may be identified as some kind of 2D-spherical membrane (bounded 3D-sphere), then for an *internal* observer practically all known solutions sufficiently depending on current BH radius and far from isotropy.

However, one comes to such solutions (including singularities) due to prolongation exterior solution into interior part. Meanwhile, another way was also proposed where any singularity is absent (e.g., "gravastar"). I just came to the more drastic idea: some topological transformation of space-time occurs at a BH collapse. So, in our Universe BH are 2D-objects in principle, not only for external observer, there is nothing inside them at all.

If so, then, maybe, our Universe is hyper-spherical envelop (black hole) in some external 4D maternal world? In this case all is consistent with proposed model. The analysis of the model theoretical and empirical consequences that is given below in the book tells me that it close to the realm than SCM. I called this model as “Theory of Spherical Expanding Universe”, briefly – SEUT.

References

[Good, 1972] I.J. Good. Chinese universes. Physics Today **25** (7).
[Kozyrev, 1991] N.A.Kozyrev *Selected works*. Leningrad, Edition of the Leningrad State University, 1991 (in Russian).
[Melia, 2016] F. Melia. “Definitive Test of the R_h = ct Universe Using Redshift Drift” arXiv:1608.00047v1.
[Pathria, 1972] R.K. Pathria. The Universe as a Black Hole (Вселенная как черная дыра) (Nature **240** (5379): 298–299).
[Smolin, 1994] Lee Smolin. The fate of black hole singularities and the parameters of the standard models of particle physics and cosmology. ArXiv:gr-qc/9404011v1 7 Apr 1994

2. TIME ORIGIN AND UNIVERSE UNIFORM EXPANDING

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Time origin and universe uniform expanding

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2.1. Introduction

It is well known that the Standard Cosmological Model (or ΛCDM) contains a number of discrepancies with the observed data and is criticized in the scientific literature. Particularly, recently several cosmologists departing from different reasons are proposed [1-6] independently the elements of a new cosmological concept, in which by contrast with ΛCDM the expanding Universe age is *strongly proportional* to its current size. Each of these publications contains the results of calculations that well correspond to the observed data. However, there is no there any fundamental explanation of such a model (excluding [2, 3]).

Since 1993 I also develop such the model [7-11]. This work was motivated by the attempt to introduce Time into the science as physically comprehensive quantity, not as a formal parameter. It was naturally to associate the universal (and irreversible) Time course phenomenon with the most general process in our Universe: its expanding. On the next step I simply identified the Universe current age with its current curvature radius.

However, this new concept's adepts do not point out the following fundamental issue: the linear link between the Universe age and size immediately *leads to the contradiction with any cosmological model, in which the conservation energy law is held.* In fact, the commonly accepted Universe evolution curve is deduced from such the law (see, e.g., [15]). It turns out that the strong proportionality between the Universe size and age immediately leads to the *linear increasing* its mass and energy with Time[1].

The modern cosmology de-facto considers the Universe as a thermodynamically isolated system, and it supposes that its total energy and matter amount does not change over all its evolution time. However, Lee Smolin refers to J. A. Wheeler and wrote in [16]:

"It may then be conjectured that each black hole of our universe leads to such a creation of a new universe and that, correspondingly, the big bang in our past is the result of the formation of a black hole in another universe."

Can our Universe be a black hole? The correct answer is: our Universe *can't not be* a black hole in some external world. This statement proof is very simple (Fig. 1). Let us

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[1] The German physician (not a physicist!) Robert Mayer was the discoverer of the energy conservation law. He formulated his idea in the paper that he sent to J. Ch. Poggendorf's "Annalen der Physik". However, the paper was not published, and Poggendorf saved his "reputation" forever. It is interesting, what the fate waits now a publication (and its editor) that supposes our Universe to not be a thermodynamically isolated system, so its total energy may to not be constant.

consider an infinite universe having a given (average) density ρ and infinite mass. Furthermore, let us select a virtual sphere having a small radius *R*. If we will increase the virtual sphere radius, its mass *M* will increase (as well as its gravitational radius R_G) proportionally to the *cube* of the geometrical sphere radius. In other words, the geometrical radius *R* is proportional to the *cube root* from the mass *M* and (hence) from the gravitational radius R_G. The non-linearity of this dependence means that starting from some critical value (depending on the density ρ) the gravitational radius will *necessary* overcome the geometrical sphere size; hence, this spherical mass will become a black hole for which the *critical* density $\rho_{cr} = 3/(8\pi R_G^2)$ will be equal to the given density ρ. So, the gravitational collapse will be inevitable, because of that our real Universe cannot be infinite.

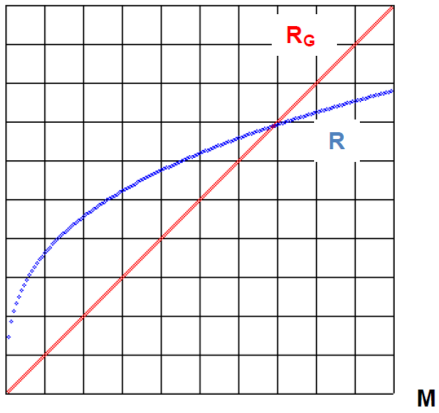

Figure 1.
Gravitational radius (R_G) and geometrical one (R) vs mass M at a given density ρ=const

Let us now consider our Universe having the average density near to 10^{-29} g/cm^3. The calculation results of the parameter (ρ/ρ_{cr}) showing the remoteness from the collapse state for different astrophysical objects are represented in the Table 1.

Table 1. Ratio (ρ/ρ_{cr}) for different astrophysical objects

Object	Mass M (kg)	Radius R (m)	Gravitational radius R_G (m)	$(\rho/\rho_{cr}) = (R_G/R)^3$
Sun	$2{\cdot}10^{30}$	$7{\cdot}10^{8}$	$3{\cdot}10^{3}$	$\sim 10^{-16}$
Milky Way	$3{\cdot}10^{42}$	$\sim 10^{19}$	$\sim 10^{15}$	$\sim 10^{-12}$
Earth	$6{\cdot}10^{24}$	$6{\cdot}10^{6}$	10^{-2}	$\sim 10^{-26}$
Universe	$\sim 10^{53}$	$\sim 10^{26}$	$\sim 10^{26}$	~ 1

From this Table it follows that the entire Universe in fact should be in the gravitational collapse state.

Note, since any black hole *irreversibly* increases its mass and event horizon surface area while "eating" the external energy and matter, it expands like our Universe.

Such the cosmological model provides many arguments that confirm it. Moreover, it successfully competes with the Standard Cosmological Model, as I believe. I will shortly call this model as SEUT (Spherical Expanding Universe Theory).

2.2. Possible Geometry of Black Hole

As it is well known, for an *external* observer in our Universe a black hole (BH) can be exactly represented by 2D membrane model that is located on the BH's bound. But what happens *inside* of BH?

The common approach provides the "prolongation" of the internal solution into internal region of BH. As result, several exotic features appear including internal singularities. Further, the internal solution effectively *depends* on a given point location relative to the BH's center, and this fact contradicts to the observable Universe homogeneity. Hence, the solution prolongation idea is not consistent with our hypothesis.

Meanwhile, there exist different approaches to describe the BH interior region. Thus, the authors of the work [17] refused such a concept of the BH's internal structure and proposed the new solution for a body endpoint of gravitational collapse. By extending the concept of Bose-Einstein condensation to gravitational systems they constructed a cold, compact object with an interior de Sitter condensate phase and an exterior Schwarzschild geometry of arbitrary total mass. These areas are separated by a phase boundary with a small but finite thickness (near to the Planck's length) of a fluid replacing both the Schwarzschild and de Sitter classical horizons. The new solution has no singularities, no event horizons, and has a global time. Its entropy is maximized under small fluctuations and is given by the standard hydrodynamic entropy of the thin shell. Unlike black holes, a collapsed star of this kind is thermodynamically stable.

On the other hand, my own study [18] basing on the General Relativity known results revealed a very interesting picture of that happens near to the *finite size body* gravitational collapse. Far from the collapse state pressure is positive and decreases continuously from the center of the body to its bound. However, it turned out that during the object contraction (but before the collapse event) a new situation appears: The pressure distribution inside of the object is fully changing. An infinite bipolar pressure break point in the center appears which is forced out to the bound while the collapse is approaching.

This impelled me to propose the more radical concept of description BHs in our Universe that also can be used as base to explain the Universe's features. The concept suggests that the membrane-shell *really* appears at the BH's event horizon, however, the *space-time topology change happens there* as a gravitational collapse result, and physical space itself disappears as such inside of BH, the bound between the interior and exterior regions of 3Dspace has the dimension number 2. Then the representation like 2D membrane becomes to be absolutely exact, not approximate. The BH total mass turns out to be concentrated uniformly in this 2D region[2], and there is no some difference depending on the distance from the BH's center[3].

In my opinion, the BH's structure transforms at the collapse. There will be *nothing* inside of the object bound, all the matter will concentrate in the boundary shell, and the BH's dimension number reduces (new dimension number is old dimension number minus 1). Furthermore, the event horizon surface area increases while it consumes a matter and energy. From the hypothetical 2D observer point view who is disposed on the surface, its 2D universe increases and the real measure of the universe variability is its total mass value.

Note, for such an observer the energy conservation law *will not accomplish* in its universe, this energy will irreversible increase. Let us emphasize the following: BH consumes an external matter and increases its size like a living organism, such the behavior is similar to the biological metabolism process. For such the systems A. Levich introduced (see [19, 20]) the notion of *Parametric Time* that simply is *linearly proportional* to a basic system resource (in this case – to the mass of the system).

2.3. Our Universe as BH in an External World. The Formalism of SEUT

When we compare our Universe's behavior with this situation, before all we find out that

[2] Last time a number of publications appeared (including the paper of the such known author as V. Frolov), in which a close model was described [17, 35, 36].

[3] Now one may understand why the environment average entropy is proportional to the medium element *volume*, and the membrane entropy is proportional to its *surface* area element.

it expands too. In 1993 I reflected on the Kozyrev's ideas [21] and came to the Universe concept as a 3D shell of a 4D *Euclidean* sphere[4] (see [7 - 14]). The increasing sphere radius I identified with the Universe age, so it received a simple and clear meaning of *Parametric Time*. In such a model the velocity of light has a status of an empirical coefficient to transit from length measuring along 3D sphere surface to the length measure along the *normal* to this sphere.

On the other hand, the velocity of light status as a *maximally possible* one simply corresponds with the maximal angle (π/2) of a possible inclination of a 4D world line relative to the spatial 3D sphere surface. Such a model can be deduced from the suggestion that *our Universe is 3D Black Hole, i.e., 3D membrane in a 4D surrounding environment*.

We can write for such the Universe the usual Einstein-Friedmann's equations:

$$k\,(c/R)^2 + (\dot{R}/R)^2 + 2(\ddot{R}/R) = -\,8\pi GP/c^2 \qquad (1)$$

$$k\,(c/R)^2 + (\dot{R}/R)^2 = 8\pi G\rho/3 \qquad (2)$$

where R is a curvature radius, G is the constant in the Newton Gravity law, c is velocity of light, ρ is a matter density, P is a matter pressure, k = 0, 1 or -1 depending on a curvature sign. Here $\dot{R}$ and $\ddot{R}$ denote the first and second derivative on time respectively.

In order to solve this system the cosmologists so far made the following assumptions. Firstly, Time was believed to be independent variable, and one did not limite *a priori* a dependence the curvature radius R on Time. Secondly, one assumes total mass (and energy) in the Universe to be constant, independent on Time. Thirdly, one assumes the matter pressure (not the radiation one) to be zero ("galaxy dust" hypothesis). The last assumption forced out to introduce in this equations the non-zero cosmological constant Λ in order to satisfy the observed data.

In the proposed model we go by another way. Contrary to the above described approach we explicitly introduce the Parametric Time that is exactly *proportional to the Universe total mass*. As it is well known, for a Schwarzschild's BH its mass is proportional to the (gravitational) radius. Because of that we set for Parametric Time $t=R/c$. In our model R is the radius of an expanding 4D sphere. At each Parametric Time point t our spatial Universe is represented by a closed 3D hyperspherical uniform surface[5]. Thus, we use the conditions $\dot{R}$ $=c$ and $\ddot{R}=0$ while solving the Einstein-Friedmann's equations. Here c is simply an empyrical factor connecting the length intervals that are parallel and normal to the 3D surface. Parametric Time axis is always oriented normally to this hypersurface.

Further, if we believe the Universe to be a BH, its total energy (and mass) cannot be unchangeable. Generally, the energy conservation law use for expanding Universe leads to some contradiction because the global energy *conservation* is due to the Noether's theorem and its premise that Time is uniform. Meanwhile, in the early Universe the metric tensor component values (hence, gravitational force values and other physical quantities) were very different. In other words, Time in the *expanding* Universe *cannot be physically uniform*.

Finally, the physicists following the Einstein's tradition believed the matter pressure to be equal to zero. But such a statement was not due to a principle, contrary, it was artificial. For example, in his classical monograph [22] R. Tolman describes the solution of the pressure and density distribution problem *inside of* a material sphere where he uses the non-zeroth pressure. Unfortunately, when Einstein considered the problem for his initial model of the *static* Universe, he did not find out a solution with positive pressure and was confused by

[4] The *pseudo-Euclidean* metrics appears in the model as artifact while one interprets the mechanical motion meaning, see [7-10].

[5] From point of view of an "external" observer, a time interval when enrgy and matter are not coming from outside is similar to a single *Parametric* Time moment because any Universe evolution activity during this interval is "frozen".

this fact. Instead of the negative pressure he introduced its *surrogate* – cosmological constant Λ. This changes nothing in mathematics or physical meaning, however, confused the cosmologists.

Because of that in our model we do not limit *a priori* the energy and pressure dependence on Time, we search for them while solving the equation system. For the *expanding* Universe we naturally come to the energy *evolution* law insead of the *conservation* one. This law turns out to be linear as should be due to Parametric Time definition. The pressure turns out to be essentially *negative*, and this has a deep physical meaning (like the Einstein's static Universe model): the negative pressure just describes the mutual matter *attraction*, i.e., negative energy of Gravity.

Using the conditions $\dot{R}$=c, $\ddot{R}$=0 we come to the new cosmological solution for the matter density ρ and matter pressure P on the curvature radius R (that is proportional to Parametric Time):

$$\rho = 3c^2 / (4\pi GR^2) \qquad (3)$$

$$P = - c^4/(4\pi GR^2) \qquad (4)$$

So, the state equation has the typical form:

$$P = - \rho c^2/3 \qquad (5)$$

As it should be, the total Universe mass is proportional to R and t. Hence, the Kozyrev's prediction that "Time transforms to Energy" (see [21]) surprisingly turns out to be true. However, in modern epoch the relative level of energy non-conservation (per year) is near to 10^{-10}, and it is very difficult to reveal it in a lab. But this effect may play a role in star and galaxy phenomena. In fact, the Sun's mass increment per year is few orders more than its loss to radiate.

So, with our approach the matter density and pressure are depending on the space curvature (are not introduced "by hand"), this fully corresponds to the Einstein's approach directed to geometrize the physics. It means (in the physics language) that matter pressure and density are features of the space curvature given to us "in sensations" (measurements). So, they represent secondary quantities, i.e., depending on it. Let us remark, such the way was denoted by Einstein himself while he introduced the Universe closed onto it-self. Thus, he replaced fixed boundary conditions by the condition of self-consistency!

2.4. Discussion

The detailed description of the model and its results is given in my publications (see reference list at the end of the paper). Here we shortly discuss the key model statements.

2.4.1. Before all, the physical meaning of *Big Bang* is specified. This is our Universe creation act as an object gravitational collapse in some External World. Because of above arguments such the Universe does not contain any singularities.

2.4.2. The *maximal* velocity existence can be connected with the maximal inclination angle (π/2) between a moving particle word line and the 3D hypersphere curvature radius. A gravitation force is also interpreted geometrically as an inclination angle between its direction and the same radius, because of that kinetic energy and gravity potential one can mutually be transformed one to another.

2.4.3. In the SEUT the Universe radius and the event horizon rise *proportionally* due to linear evolution. This resolves the known "horizon problem", one does not need in the "initial inflation" hypothesis.

2.4.4. The nova-day observation allowed us to find out the angular size ~0.6°

corresponding to the maximal peak of the CMBR spectrum [23]. From that one deduces in the Standard Cosmological Model (SCM) that the Universe spatial geometry is *flat*. Further, from it follows that *average* matter density is practically *equal* to the *critical* one. If one uses the especially fitted value of Λ, then he reveals in SCM a *non-linear R* dependence on Time. From this one concudes that the Universe expands with some *acceleration* in the modern epoch, so our epoch seems to be a *special one*.

Meanwhile, in the work [24] it is shown that exact location of the spectrum maximal peak can be determined *independently* on the Universe spatial metrics type. At this our model states:

- Our Universe metrics at any evolution time point has a *positive* curvature and (respectively) spherical geometry, its *real* density is always *two times more than* critical one[6].
- The Universe over all the evolution time expands with a constant rate, and our epoch is not an especial one, so there is no any accelerating (or decelerating) expansion.

2.4.5. The hardly established phenomenon of the CMBR dipole anisotropy is in some collision with the fundamental idea of the Relativity on the preferred reference frame absence. But our model (SEUT) just supposes that there is such a preferred reference frame at every spatial point of the Universe that explains the dipole anisotropy phenomenon [25]. However, the velocity corresponding to this anisotropy is only ~0.001 of velocity of light, because of that we have a good concordance with relativistic picture.

2.4.6. There is one more interesting aspect. The both CMBR temperature power spectrum and temperature-polarization cross-spectrum have the peak[7] at the multipole number $\ell \approx 5$. The SCM is not able to explain satisfactory this phenomenon. However, our model predicts the existence of just such the peak due to relic photons travelling along the expanding Universe over (360 + 40)°, see [26].

2.4.7. As it is known, the forced introduction of the non-zero Λ in the SCM creates a new (practically unresolved) "problem of the vacuum" (see review [27]): The estimation of the vacuum energy is 122 order less than quantum mechanical calculations actually give. Furthermore, in my opinion, the vacuum zero-point oscillations energy cannot be extracted and used for the Universe gravitational expansion, nor for any something, because it corresponds to the lowest energy possible state. Finally, the Universe size changes with time, while the value of Λ is considered as constant. What about the SEUT, it does not contain the cosmological constant, however there is the same concordance with the observed data as in the SCM.

2.4.8. In the SCM the fact that at given redshift a distant Supernova seems to be dimmer than one expected is explained using the especially fitted cosmological constant value Λ. Meanwhile, in the SEUT one does not need use some "free" parameter Λ, it gives immediately the result that corresponds to the observed data and the SCM prediction [28].

2.4.9. There is the important cosmological test: the mean galaxy angular size dependence on redshift. Several recently published papers show that the observed data does not correspond with the SCM prediction. Meanwhile, we made some theoretical investigation where practically obtained the SEUT predictions satisfactory concordance with the observed data using certain assumptions (see [29]).

2.4.10. The present-day cosmology *de-facto* considers the Universe as thermodynamically closed system, particularly while one integrates the Einstein-Friedman equations. This generates a number of difficulties when one explains the actual situation including the total discrepancy from the equilibrium state. Because of that *de-jure* the cosmology refers the General Relativity that considers the world as a system in the alternative gravitational field (not as closed system) for which the second law of

[6] This is confirmed by the observed data connecting galaxies angular size with its redshift (see [30]).
[7] See [31].

thermodynamics can not be satisfied. My model proposes a new point of view on our Universe thermodynamics. In this model the Universe entropy *decreases* (not increases) since (like working medium of a heat engine) it receives energy from outside at a relatively high temperature (few kelvins) and gives it up to own (interior) supermassive BHs at a practically equal to zero temperature[8]. Because of that the cosmological Arrow of Time origins from thermodynamics and is primordial relative to biological (evolution) and psychological Arrows. This is the reason of a Universe structure continuous differentiation and increasing deviation of the Universe state from equilibrium during 13.8 billions years of Parametric Time [32].

2.4.11. In the September of 2013 I revealed one more serious argument that has confirmed the SEUT (as I believe). It is associated with so-called “extremely large Dirac numbers”. The full description of this problem is given in [34], and here I describe its resolution shortly. On the one hand we can define the Plank mass and size using dimensionality reasons only:

$$m_p = \sqrt{\frac{\hbar c}{G}} \approx 2.1 \cdot 10^{-5} g \text{ , } l_p = \sqrt{\frac{\hbar G}{c^3}} \approx 1.6 \cdot 10^{-33} cm$$

Note that their ratio is

$$\frac{m_p}{l_p} = \sqrt{\frac{(\hbar c / G)}{(\hbar G / c^3)}} = \frac{c^2}{G} \approx 10^{28} g / cm$$

On the other hand, from the well known link between a body gravitational radius and mass ($R = 2GM / c^2$) we can deduce the same ratio between the nowadays Universe corresponding parameters:

$$\frac{M_U}{R_U} \approx \frac{c^2}{G}$$

If m_p and l_p specify our Universe immediately after Big Bang, then one could see that this ratio remains always constant, so the SEUT may be considered as confirmed. One also can see that the important expression follows from the two preceding relationships:

$$\frac{M_U}{m_p} = \frac{R_U}{l_p} \approx 10^{60} \equiv D$$

This quantity that I proposed to name “Dirac’s number” is dimensionless Universe lifetime.

References

[1] Shlomo Barak and Elia M Leibowitz. Cosmology and Astrophysics without Dark Energy and Dark Matter” (arXiv: astro-ph 0909.2581).
[2] A.Benoit-Lévy and Gabriel Chardin. Do we live in a Dirac-Milne Universe? **(**arXiv:0903.2446v1).
[3] A.Benoit-Lévy and Gabriel Chardin. Introducing the Dirac-Milne Universe. (arXiv:1110.3054v1)
[4] F.J.M. Farley. Does gravity operate between galaxies? Observational evidence reexamined (arXiv:1005.5052v1)

[8] The supermassive black holes in the centers of galaxies give a dominant contribution into our Universe’s entropy (see [33]).

[5] Melia F., Shevchuk A. S. H., 2012, MNRAS, 419, 2579
[6] Melia F. The Cosmic Spacetime. Is The Universe Much Simpler Than we Thought? (arXiv: 1205.2713v1)
[7] M. H. Shulman. On Time physical origin. Moscow, IRC RAO "Gazprom", 1997 (in Russian).
[8] M. H. Shulman. Cosmology and Time Origin. In "Freedmanovskie Chtenia", All-Russian Scientific Workshop, Perm, 7-12 September, 1998 (p.p. 20-22) .
[9] M.H. Shulman. Time as Phenomenon of the Expanding Universe. New Energy Technologies. Issue # 4 (7) July-August 2002.
[10] M.H. Shulman: Paradoxes, Logics, and Physical Nature of Time.
http://www.timeorigin21.narod.ru/rus_time/Origin.pdf (in Russian)
On the Time, Motion and Matter physical Meaning.
http://www.chronos.msu.ru/EREPORTS/shulman_on_the_time.htm (in English)
[11] M.H. Shulman. Cosmology: a New Approach. [See Appendix 1]
http://www.timeorigin21.narod.ru/eng_time/Cosmology.pdf
[12] M.H. Shulman. Kozyrev's Time. In "Time and Stars: the Centenary of N.A. Kozyrev ", Nestor-Istoria, St. Petersburg, 2008 (p.p. 556-561) (in Russian) [See Appendix 2].
[13] M.H. Shulman. Time as Phenomenon of the Expanding Universe. In "On the Way to Understanding the Time Phenomenon: the Constructions of Time in Natural Science". Progress-Traditia, Moscow, 2009 (p.p. 207-234) (in Russian)
[14] M.H. Shulman. Alternative Cosmology (in Russian).
http://www.timeorigin21.narod.ru/rus_time/Alt_cosmology.pdf
See short book's presentation in English
http://www.timeorigin21.narod.ru/eng_time/Presentation_eng.pdf
[15] A. Einstein. The Meaning of Relativity. Princeton, 1953.
[16] Lee Smolin. The fate of black hole singularities and the parameters of the standard models of particle physics and cosmology. ArXiv:gr-qc/9404011v1 7 Apr 1994
[17] Pawel O. Mazur and Emil Mottola. Gravitational Condensate Stars. An Alternative to Black Holes. ArXiv:gr-qc/0109035v5 27 Feb 2002
[18] M.H.Shulman. Usual collapse and unusual one. [See Appendix 3]
http://www.timeorigin21.narod.ru/eng_time/Collapse.pdf
[19] A.P. Levich. Metabolic time of natural systems // System Studies. Annual edition. 1988. Moscow: Nauka. 1989. Pp.304-325 (in Russian).
[20] A.P. Levich. Time as Variability of Natural Systems: Ways of Quantitative Description of Changes and Creation of Changes by Substantial Flows // On the Way to Understanding the Time Phenomenon: the Constructions of Time in Natural Science. Part 1. Interdisciplinary Time Studies. Moscow, Singapore, New Jersey, London, Hong Kong: World Scientific. 1995b. Pp.149-192. http://www.chronos.msu.ru/EREPORTS/levich1.pdf
[21] N.A. Kozyrev. Selected works. Leningrad, Edition of the Leningrad State University, 1991 (in Russian).
[22] R.C. Tolman. Relativity, Thermodynamics, and Cosmology. Oxford, Clarendon Press, 1934.
[23] Komatsu et al. Seven-Year Wilkinson Microwave Anisotropy Probe (WMAP) Observations: Cosmological Interpretation. ArXiv: 1001.4538v2 [astro-ph.CO] 12 Feb 2010
[24] M.H. Shulman. Universe expansion and main spectral peak of CMB. [See Appendix 4]
http://www.timeorigin21.narod.ru/eng_time/Main_peak_eng.pdf
[25] M.H. Shulman. On an experimental validation of the selected reference frame existence in the Universe. [See Appendix 5]
http://www.timeorigin21.narod.ru/eng_time/On_the_selected_reference_frame.pdf
[26] M.H.Shulman and G.Raffel. On the oldest photons phenomenon. [See Appendix 6]
http://www.timeorigin21.narod.ru/eng_time/Oldest_photons_eng.pdf

[27] Raphael Bousso. TASI Lectures on the Cosmological Constant. ArXiv: 0708.4231v2 [hep-th] 11 Sep 2007
[28] M.H.Shulman. On the supernovae low luminosity problem. [See Appendix 7] http://www.timeorigin21.narod.ru/eng_time/On_supernovae.pdf
[29] M.H. Shulman and G. Raffel. On galaxies angular size evolution. [See Appendix 8] http://www.timeorigin21.narod.ru/eng_time/angle_size_evolution_eng.pdf
[30] Weinberg S. Gravitation and Cosmology: Principles and applications of the General Theory of Relativity. John Wiley and Sons, Inc., 1972.
[31] Dunkley et al. Five-Year Wilkinson Microwave Anizotropy Probe (WMAP) Observations: Likelihoods and Parameters from the WMAP data. ArXiv: astro-ph/0803.0586v1 5 Mar 2008
[32] M.H. Shulman. Time, entropy, and Universe. [See Appendix 9] http://www.timeorigin21.narod.ru/eng_time/Time_and_entropy_eng.pdf
[33] Ch. Egan and Ch. Lineweaver: A larger estimate of the entropy of the universe. ArXiv: 0909.3983v1 [astro-ph.CO] 22 Sep 2009.
[34] “Extremely Large” Dirac Numbers and Fundamental Constants in Cosmology. [See Appendix 10] http://www.timeorigin21.narod.ru//eng_time/Dirac_number_eng.pdf
[35] Valeri P. Frolov. Do Black Holes Exist? arXiv:1411.6981v1 [hep-th] 25 Nov 2014
[36] Robie A. Hennigar and Robert B. Mann. Super-Entropic Black Holes. ArXiv:1411.4309v1 [hep-th] 16 Nov 2014

APPENDIX 1. Cosmology: a New Approach

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I propose to consider Time as the Universe expansion phenomenon. All the world processes present a part of this general one. The new solutions of the Einstein-Friedmann's cosmological Equation are found out and investigated. One can deduce many consequences from this concept (which presents a generalization of the Einstein's General Relativity), including Cosmological constant problem, Universe flatness and horizon problems, Universe accelerated expansion problem, Cosmic microwave background radiation (CMBR) anisotropy problem, initial part of the CMBR cross spectrum explanation, low SN luminosity explanation, Universe origin problem, etc.

1. Introduction

As first approximation one may consider all Universe as a sphere having the center at any point and uniformly filled by a matter with average density ρ. Such presentations correspond with the simplest cosmological Einstein-Friedman model treating 3D non-Euclidian space, which has variable in time curvature radius R. The space in this model is supposed as isotropic one and filled by a "dust" matter; time presents as formal parameter determining "current" space curvature. The Einstein equations can be written as **[Zeldovitch, Novikoff, 1975]**:

$$k(c/R)^2 + (\dot{R}/R)^2 + 2(\ddot{R}/R) = - 8\pi GP/c^2$$
$$k(c/R)^2 + (\dot{R}/R)^2 = 8\pi G\rho/3,$$

where G is the Newton gravitation law constant, c is the velocity of light, ρ is a density, P is a pressure, k = 0, 1 or -1 (depends on the curvature sign). Characters $\dot{R}$ and $\ddot{R}$ denotes here the first and second order derivative on time.

If we suppose that the both static and dynamic matter pressure P are equal to zero then we have three well known solutions. Some choice between them depends on a relation between real (ρ) and "critical" ($\rho_{кр}$) mean matter density value in the Universe:

- If $\rho > \rho_{cr}$, then the curvature is positive, the curvature radius firstly increases with time, then decreases;
- if $\rho_{cr} > \rho > 0$, then the curvature is negative, the curvature radius increases at no allowance;
- if $\rho = \rho_{cr}$, then the curvature is absent, the Universe has the flat metrics.

Here the critical density means it is equal to the value

$$\rho_{cr} = 3H^2/ (8\pi G)$$

where H is the Hubbles parameter. Note that in case $\rho = \rho_{cr}$ the Hubbles parametr is inversely proportional to the Universe age.

In my opinion, this commonly accepted standard model contains two incorrect fundamental assumptions, which imply some important divergence relative to correct interpretation of the cosmological realty.

The first assumption just consists in neglect the mean static matter pressure in the Universe. Of course, It is very small, but it just allows us to solve several "unsolvable" problems like “dark energy” problem, its disproportion with the vacuum fluctuations energy, and true meaning of the cosmological constant that A. Einstein created, then killed, and modern cosmologists returned. The proof of necessity to account a static pressure is connected with the total matter distribution and may be deduced from following chain of steps. Initially, let us consider a uniform sphere consisting in ideal liquid and an “empty” space surrounding this sphere. Inside of the sphere a pressure, of course, depends on the distance from the center and is non-zero (in the Section 2 we discuss the Schwarzshild’s solution for General Relativity). Further, as Einstein’s great idea provides, let us eliminate all the external space and go to “close” this sphere on itself. Then the geometry inside of the sphere becomes to be Riemann’s one, and a pressure in any point of the sphere as before is non-zero, but now its value *do not depend* on the point due to equality of them. Finally, if the sphere matter density is great enough, the sphere starts to collapse, so the pressure sign becomes to be opposite to the density sign (see for the Section 3).

The second assumption is discussed in the publication using the extremely “heretic” position. When solving the EF-equations system, one uses the inertial mass (i.e. energy) conservation law in the Universe during the all its history. I just state that it is incorrect, if we use an alternative approach, we could overcome the important difficulties in the modern cosmology (see for the Section 4).

I believe, some analogy with the fifth postulate of Euclid is present here. It seemed to be inviolable before Lobatchevsky and Gauss, but now any student-mathematician perceives it only as some limiting axiom of the simplest possible geometry. Analogously, after famous Paris Academy decision the scientific community rejected for ever to consider some situations where the energy conservation law is not executed. However, this law corresponds with the Nöeter’s theorem, and is due to the time uniformity. There are all the reasons to verify did that condition be really accomplish during the Universe evolution. I will discuss this question in the Section 4.

2. On static pressure inside a material body

Let us now consider the gravitational field of the uniform material sphere having central symmetry. The problem was successfully solved by Schwarzshild in the frame of the General Relativity. In particular, inside a uniform sphere with radius r_1 and density ρ the matter pressure P (of an ideal liquid) is described by relationship (see for. **[Tolman, 1934]**):

$$P = \Phi(r, r_1, R)\, c^4/(8\pi G R^2)$$

where the curvature radius R is determined as

$$R^2 = 3c^2/(8\pi G\rho)$$

and the function $\Phi(r, r_1, R)$ is given by the fraction

$$\Phi(r,r_1,R) = \frac{3\sqrt{1-(r/R)^2} - 3\sqrt{1-(r_1/R)^2}}{3\sqrt{1-(r_1/R)^2} - \sqrt{1-(r/R)^2}}$$

It is easy to see that the Schwarzshild’s solution connects the sphere matter density with the internal static pressure through the curvature radius. It gives the finite (non-zero) pressure at any small (non-zero) matter density.

The author of **[Tolman, 1934]** notes, that a solution is as a rule real, because the sphere radius r_1 is usually less than the curvature radius R. In fact, the gravitational radius R_G of such sphere is

$$R_G = 2GM/c^2 = 2\,(4\pi r_1^3 G\rho)\,/(3c^2) = r_1^3\,/R^2$$

from where we have

$$R_G\,/r_1 = (r_1/R)^{\,2}$$

As the fraction "the gravitation sphere radius / the geometric sphere radius" is usually very small, the fraction "the geometric sphere radius / the curvature radius" is very small too. In this case the factor $\Phi(r, r_1, R)$ is positive and it slowly decreases up to zero while the current distance r increases from zero up to its natural limit r_1 (see for the detail analysis **[Shulman, 2007a]**).

Let us now consider as such sphere all the Universe. One may neglect a possible static matter pressure because it is very small; however, we could not be sure that a final solution will be correct. Furthermore, when we analyze the cosmological problem, the situation seems to be more complicate, as I believe.

In fact (see for **[Gurevitch and Glinner, 1972]**), at the Universe mean matter density order 10^{-30} g/cm^3 the Universe gravitational radius must be equal to 10^{28} cm, it is not probably less than its geometric size. Then, the fraction "geometric radius r_1 / curvature radius R" is probably more than 1. Really, if we express the Universe full mass $M = \rho\cdot V$ through the mean density[9] $\rho = 3c^2 / (4\pi GR^2)$ and the volume $V=2\pi^2R^3$ of 3D non-Euclidean sphere, we receive the confirmative relationship

$$R = 2MG\,/\,(3\pi c^{\,2}) = R_G\,/\,(3\pi)$$

where $R_G = 2MG/c^2$ is the Universe gravitational radius.

For the high collapsing sphere case (at $r_1/R >> 1$) the expression under the radical in the factor $\Phi(r, r_1, R)$ will be negative, then we have to transform the factor to the form:

$$\Phi(r, r_1, R) = \frac{3\sqrt{(r/R)^2 - 1} - 3\sqrt{(r_1/R)^2 - 1}}{3\sqrt{(r_1/R)^2 - 1} - \sqrt{(r/R)^2 - 1}}$$

Now the pressure is just negative. Let us neglect the units under radicals and consider a central sphere region $R < r << r_1$. We find out that in this case the limit for $\Phi(r, r_1, R)$ is -1, and we have at this condition

$$P = -\,c^4/(8\pi GR^2) = -\,\rho c^2/3$$

Note, that at exact equality $(r_1/R) = 1$ the pressure is negative too, and the value of $\Phi(r, r_1, R)$ is exactly equal to -3 in every point inside the sphere (i.e. $P = -\,pc^2$).

So, all the density energy-momentum tensor components for an uniform sphere are generally different from zero at any small (but finite) matter density ρ. We have not some reasons to neglect a matter static pressure that is due to the gravitation, and which is present as well in theory as in realm.

[9] See for the Section 3

3. New solutions of the cosmological equations

Using the Section 2 results, we now do not have to neglect a priori a matter static pressure P. The more, we have to introduce it into the equation as a unknown value, that has to be determined after solution. However, in order to solve the equation, we also need replace the Universe matter and energy conservation assumption on time by some other hypothesis (see for discussion this rejected assumption in the Section 4).

One can propose as such alternative hypothesis any version of the Universe expansion. Particularly, we set $\ddot{R} = 0$, i.e. let us will *exclude* the possibility of the Universe size *nonlinear* evolution. Now we have got very remarkable solutions. We come to the main equation to determine a pressure P

$$k(c/R)^2 + (\dot{R}/R)^2 = -8\pi GP/c^2$$

and standard state equation for P and a density ρ:

$$P = -\rho c^2/3$$

Below a set of solution with $\ddot{R} = 0$ is given:

$\dot{R}$	k	The transformed equation	ρ	P
0	0	$0 + 0 = -8\pi GP/c^2$	0	0
	1	$(c/R)^2 + 0 = -8\pi GP/c^2$	$+3c^2/(8\pi GR^2)$	$-c^4/(8\pi GR^2)$
	-1	$-(c/R)^2 + 0 = -8\pi GP/c^2$	$-3c^2/(8\pi GR^2)$	$+c^4/(8\pi GR^2)$
± c	0	$0 + (\pm c/R)^2 = -8\pi GP/c^2$	$+3c^2/(8\pi GR^2)$	$-c^4/(8\pi GR^2)$
	1	$(c/R)^2 + (\pm c/R)^2 = -8\pi GP/c^2$	$+3c^2/(4\pi GR^2)$	$-c^4/(4\pi GR^2)$
	-1	$-(c/R)^2 + (\pm c/R)^2 = -8\pi GP/c^2$	0	0

Einstein just considered the steady state solution with $\dot{R} = 0$, $\ddot{R} = 0$, k = 1. However, he did not account the static matter pressure, therefore he has to introduce the famous cosmological constant, else he could not find any solution. Since that time the cosmological constant meaning and value problem stays open right up to this moment. Such the methodological tradition costs are.

What about us, we find now the relationship between a pressure and a curvature radius:

$$\rho = 3c^2/(8\pi GR^2)$$

But this result is just the same as the limit solution ($R < r << r_1$) of the collapsing uniform sphere problem that was considered before[10].

The second remarkable solutions appears (at k = 1), if we suppose $\dot{R} = c$, $\ddot{R} = 0$; in this case the curvature radius increases strictly proportional to time. This solution has a fundamental physical meaning: the Universe expansion process just presents the time currency itself, any alternative "labels" of the Universe age are in principle absent.

If we use this second hypothesis (linear expansion condition) in the EF-equations, we have:

$$2(c/R)^2 = -8\pi GP/c^2$$
$$2(c/R)^2 = 8\pi G\rho/3$$

[10] Note, the steady state case $\dot{R} = 0$, $\ddot{R} = 0$, k = -1 corresponds with the negative matter density and general its repulsion.

Now the factor connecting the pressure and the curvature radius is two times more than for the stationary case. However, in the both cases the relationship between the pressure and the density (the state equation) is the same:

$$P = -\rho c^2/3$$

One should note, the second solution does not contain implicitly such variable as time, that confirms the given interpretation. Furthermore, the linear curvature radius dependence on time is postulated and should not deduce from some relationships; the postulate makes it physically independent (on time) on the matter density. From here on can deduce a conclusion, which contradicts to the common tradition of the field solution, but fully corresponding with the Einstein approach esprit that is directed to the physics geometrization. It consists in searching for the matter density and pressure as dependences on the space curvature, not contrary:

$$\rho = 3c^2/(4\pi GR^2)$$
$$P = -c^4/(4\pi GR^2)$$

In the physics language it means that the matter density and pressure just present several space curvature characteristics which are given us through our feeling, i.e. they are secondary ones, depending on the curvature. This way was denoted by Einstein himself, he introduced the self-closed Universe, i.e. replaced the boundary conditions by the solution self-consistency condition.

4. Gravitation theory and energy conservation law

Up to now physics treated only a models where the energy and full mass consevation law were considered as true in principle. Particularly, as I noted above, the commonly accepted solution of the EF-equations was found out just at the condition of the Universe mass and energy constance during all the its history.

As the new solution is found out for the case R' = c, so the Hubbles constant has to be inversely proportional to the Universe radius and age. There is an essential difference between this solution and the similar one of Friedmann: the new solution corresponds with the 4D sphere positive curvature (not to the flat metrics!), however in this case the density is always equal to $3H^2/(4\pi G)$, i.e. to the value $2\rho_{cr}$.

Correspondingly, the Universe mass that is equal to the mean density and the volume production will not be now constant; it will be proportional to the curvature radius and to the age. But does the Universe full mass (and energy at rest) inconstancy present a catastrophe that implies to reject such solution? I believe the situation is not so dramatic.

As it is known, the energy conservation law is strongly corresponding to such purely "geometrical" feature of the Universe as the time uniformity. It means generally, a physical process currency does not depnd on the process starting time – yesterday, one hundred or billion years ago. Such corresponding is due to the next fact: the time derivative of the close system Lagrange function does not implicitly depend on time; it means the partial time derivative of such function is equal to zero.

Even in the frame of the non-relativistic mecanics we could doubt the postulate the all physical processes currency does not depend on a region curvature where the processes occure. Note, the master Lagrange equations follow the variational principle, which states that a real space trajectory corresponds to a minimal value of the action. If the time curvature changes with time, then the variation starting and final points choice influences in principle to the varying trajectories set and type. This circumstance excludes generally the result independence on this choice, i.e. the time uniformity postulate. When we consider the relativistic mechanics, we can see directly that the fundamental metric tensor depends on the Universe current curvature, this tensor determines a mechanical motion parameters. Furthermore, some other fundamental variables could depend on the Universe current curvature radius, i.e. Planck constant **[Shulman, 2004]**).

Generally, when one treats the energy conservation law in the General Relativity, he follows some tradition rather than any strict reason. That implies several known difficulties and the physicists differents opinions, see, for example, **[Logunoff, 1988]**.

In fact, the Einstein equations corresponding with the physical realty just have to be used as theory starting point and to allow us to the famous Noeter's theorem. In the true theory the mean matter density and full Universe mass dependence on time have to bring about an exact ot approximate the mass and energy conservation law, and not contrary. So, this circumstance makes clear the energy conservation problem in the Universe and explicites the time arrow existence.

It is the important reason to replace the "Big Bang" concept by a model of "Energy Pump". The Universe initial singularity becomes now not so essential, because the initial mass and energy values are equal to zero too in our model.

Starting from the astrophysical observations, N. Kozyrev **[Kozyrev, 1991]** talked about the star radiation unified origin basing on "a time tranformation" to an energy. Our model implies the relative star mass and energy increment that is equal to the Universe relative age:: $\Delta m/m = \Delta E/E = \Delta t / t$. From here one may deduce that an additional energy may produce a radiation power per star mass unit that is proportional to the Hubbles constant (in our model this constant is $H = 1/t$):

$$\Delta E/(\Delta t{\cdot}m) \leq c^2H$$

So, the Sun relative mass decrement per year due to the radiation is up to 10^{-13}, and the Universe current age performs the relative mass increment up to 10^{-10}. Note, with the Sun's mass 10^{30} kg and the annual increment 10^{18} kg the relative increment is close to 10^{-12}, and just such increment is needed to explain the real annual increment (15 sm) of the distance between the Sun and the Earth[11].

5. What the new approach does give

The new approach was formulated starting from theoretical reasons only. However, it turns out as fruitfull one relative to practical solution of cosmological problems.

Cosmological constant problem

As we know, the cosmological constant Λ presents the Einstein's intentions to save the Universe static model solution. Futrher, this constant was repeatedly introduced into time-dependent models in order to "fit" the cosmological observations (see below). However, two new fundamental problems appear that solution was not found before now.

The first one is to find a physical explanation for the formal introducing of the cosmological constant Λ into EF-equations. One proposes to interpret "the dark energy" corresponding with Λ as vacuum zero-oscillations. But the astrophysical observations give (see, for example, **[Klapdor-Kleingrothaus, Zuber, 1997]**) for the hypothetical vacuum density value near 10^{-30} g/sm^3, at the same time the quantum mechanical calculation estimates it as 10^{92} g/sm^3, i.e. difference is incredible (122 orders)! However, there is the stronger reason: the vacuum zero-oscillations energy cannot at all be used for the Universe gravitational expansion or for anything, because of correspondence to the state with the minimal possible energy.

[11] arXiv:0907.2469v1 [gr-qc] 14 Jul 2009. J. Anderson et al. Astrometric Solar-System Anomalies.

The second problem “is frequently overlooked”[12], but it has at least the equal significance. When any non-zero value Λ is introduced into EF-equations, then the length scale $R = (\Lambda/3)^{-1/2}$ is determined. As now $\Lambda = 10^{-56}sm^{-2}$, we can identify R as the current Universe size (10^{28} sm). But the Universe size changes with time, and the Λ value is considerd as constant (at least while one “fits” a cosmological model to correspond the astrophysical data). So, what is a meaning of the quantity $(\Lambda/3)^{-1/2}$?

The both problems disappear in the frame of our approach. One has not to introduce any constant Λ into equations at all, the close result is obtained automatically by accounting of the static matter pressure P and the corresponding volumetric gravitation (not vacuum oscillations!) energy. At that one can easily explain the correspondence between the *hypothetical* quantity Λ and a *current* Universe size R. In fact, in the cosmological equations this (needless) *hypothetical* quantity Λ is setting equal to $8\pi G\rho$ (if the light velocity c = 1). But our *new* solution (at c = 1) gives for a density ρ:

$$\rho = 3 / (4\pi G R^2)$$

From that follows

$$\Lambda = 8\pi G \cdot 3/(4\pi G R^2) = 6/R^2$$

So, we have

$$R = (\Lambda /6)^{-1/2}.$$

<u>*Universe flatness and horizon problems*</u>

The experimental results show that the Universe full mean density ρ is practically equal to the critical value ρ_{cr}. One usually deduce from this that the Universe is “flat” at the modern epoch, so our epoch is a “special” one.

However, the new approach proposes another conclusion: our epoch is not special or selected, the Universe metrics has always a positive curvature, but its density is constantly equal to $2\rho_{cr}$ at every current value H. Such discrepancy of astrophysical data is bad for our model, but may be explained by someway in future.

Also, the “horizon” problem is well known in the commonly accepted cosmological model, it is connected with the Universe global spatial uniformity **[Sazhin, 2002]**. One usually connects the uniformity with the Universe phase inflation existence, i.e. superfast expansion at the first time of its evollution. Meanwhile, in the frame of our model the horizon moving off velocity is exactly the same one as the Universe expansion velocity, so the problem is just absent.

<u>*Universe accelerated expanding problem*</u>

Last years it is commonly accepted to believe that the experimental data points to a transition to the Univerce accelerated expansion. The main argument is based on the low Supernovae type Ia luminosity: it is predicted by the Universe model having some cosmological constant value Λ (which is fitted in order to optimally correspond with experiment).

Meanwhile, in the frame of the proposd approach one could easy come to the satisfactory quantitative the supernovae low luminosity explication, it is based on the Universe linear on time expansion **[Shulman, 2007b]** without any model fitting. This approach exludes any accelerated or decelerated expansion by definition.

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[12] The author of review **[Bousso, 2007]** wrote: “Today’s cosmological constant was dynamically irrelevant in the early universe. This is one of the greatest difficulties in solving the cosmological constant problem, and it is frequently overlooked”

Cosmic microwave background radiation (CMBR) anisotropy problem

The cosmic microwave background radiation (CMBR) dipole anisotropy was discovered and surely confirmed in the second half of the 20^{th} century. This fact's commonly accepted explanation is yet absent, and it conflicts to the Relativity postulate, wich says there is no any selected reference frame in the Universe.

However, our model of the time physical origin that is due to the Universe expansion phenomena directly points out to the necessity of the Einstein representations generalisation and to the just such "selected" reference frame existence. Moreover, the model predicts that the anisotropy exists for each (not only relict) electromagnetic radiation. For example, and it may be tested experimentally, such anisotropy has to exist for the Sun light coming to Earth at the different phases of its orbital moving around Sun, or for any radiation from the monochrome sourse wich should be differently oriented relative to the anisotropy axis **[Shulman, 2007c]**.

Additionally, the anisotropy is also specified by higher-order multipoles values. If the Universe was infinite, then we reached the significantly large values than the real quadrupole and octupole values that WMAP found.

Also, there is an interesting peak at the multipole number 4 as well on the temperature correlation spectrum as on the cross-correlation specrum between the temperature and the so called polarization E-mode of CMBR. The typical models cannot explain satisfactory this phenomenon. However, my approach just predicts such peak and explains it using the oldest photons existence which made a full world tour around the Universe. Now they arrive at the angle near 40° **[Shulman and Raffel, 2008]**.

Universe origin problem

The Friedmann cosmology could not say something about the Universe origin. Contrary, our approach allows to investigate this problem. As is noted in **[Tolman, 1934]**, the metrics of any material sphere having non-zero density becomes a violated one relative to Euclidean metrics, its geometry present a 4D spherical supersurface one.

The plot of the metric tensor component g_{00} for a collapsing object gravitational field one may liken to a small "pit" that the curvature radius is much more than its geometrical size. However, if the matter density increases and collapse comes near, the metrics becomes deformed, so finally "the pit" transforms to some kind of "bulb", which is connected with the external supersurface by a bulb narrow neck only. Just this neck (or its part) is available for an external observer, and the gravitation insuperable barrier transforms the object central region to a "lost world".

From the external world point of view it is black hole absorbing irreversibly a matter and radiation. At another hand, for an inhabitant of the black hole the "navel-string" connecting it with the external world, has to be seem to a spherical white hole, from which a matter and radiation appear continuously and allow probably to estimate the external world features.

It is possible that we are the inhabitants of such black hole? I believe, yes. The pressure negative sign just comes to this conclusion. The Universe insularity itself becomes physically clear.

In the modern General relativity one may study the collapse in three different reference frames. One usually operates with the "point" mass model. The first reference frame is connected with an external observer, the second one corresponds with a matter dropping into the black hole, and the third one is the internal observer reference frame inside collapsing object.

From the external observer point of view the matter dropping time into a collapsing time is infinitely large. But if we operate with the concomitant reference frame then this time becomes finite. In the concomitant reference frame the both time and space variables should be expressed through two types of the external system coordinates, and in the internal reference frame time and space should be generally replaced one by other, the metric tensor components become depending on time (not on space). Further, every material point history starts (in this concomitant reference frame) in the zero moment and ends after the same finite time interval in the special singular point, after which nothing exists ("the time barrier").

As I believe, if one considers a non-point collapsing object, another conjunction of the external and internal collaps pictures is possible. Now we know, that the same time interval may be as well finite as infinite in a different reference frames. So, we could suggest that an unlimited black hole collapse in the external Super-Universe presents an unlimited expansion in our Universe that starts from a singular point. And the same point presents the all Super-Universe material bodies (that drop to the black hole) hystory end. Note, the time arrow inside black hole is not opposite to the external one, they are independent.

6. Conclusion

So, if one accounts the static compression pressure due to mutual matter gravitation in the Universe, and rejects the matter conservation law, he could find out the new EF-equations solution, where metrics has the curvature finite positive radius linearly increasing with time. The new approach allows to find out the non-trivial (but natural) solution of many difficult cosmological "misteries".

Bibliography

[Bousso, 2007] Raphael Bousso. TASI Lectures on the Cosmological Constant. arXiv:0708.4231v2 [hep-th] 11 Sep 2007

[Gurevitch and Glinner, 1972]. L.E. Gurevitch, E.B. Glinner. *General Relativity after Einstein*. Moscow, Znanie (Physics ser.), 1972 (in Russian).

[Klapdor-Kleingrothaus, Zuber, 1997] H.V. Klapdor-Kleingrothaus, K.Zuber *Teilchenastrophysik*. B.G. Teubner GmbH, Stutgart, 1997

[Kozyrev, 1991] N.A.Kozyrev *Selected works*. Leningrad, Edition of the Leningrad State University, 1991 (in Russian).

[Logunoff, 1988] A.A.Logunoff. *New representation of space, time, and gravitation*. The international year-book "Science and humanity", 1988 (in Russian).

[Sazhin, 2002] M.V.Sazhin. *Modern cosmology in popular exposition*. Moscow, "Editorial URSS", 2002 (in Russian).

[Tolman, 1934] R.C.Tolman. *Relativity, Thermodynamics, and Cosmology.* Oxford, Clarendon Press, 1934.

[Shulman, 2004] M.H.Shulman *Variations on quantum theory*. Moscow, "Editorial URSS", 2004. Available at:
http://www.timeorigin21.narod.ru/rus_quantum/Variations.pdf (in Russian),
http://www.timeorigin21.narod.ru/eng_quantum/Eng_variations.pdf (shortly).

[Shulman, 2006] M.H.Shulman *Paradoxes, Logics, and Physical Nature of Time.* Available at: http://www.timeorigin21.narod.ru/rus_time/Origin.pdf (in Russian)**,**
http://www.timeorigin21.narod.ru/eng_time/Eng_paradoksy.pdf (shortly)

[Shulman, 2007a] M.H.Shulman *Usual collapse and unusual one*. 2007. Available at: http://www.timeorigin21.narod.ru/eng_time/Collapse.pdf

[Shulman, 2007b] M.H.Shulman *On the supernovae low luminosity problem*. 2007. Available at: http://www.timeorigin21.narod.ru/eng_time/On_supernovae.pdf

[Shulman, 2007c] M.H.Shulman. *On an experimental validation of the selected reference frame existence in the Universe. 2007.* Available at:
http://www.timeorigin21.narod.ru/eng_time/ On_the_selected_reference_frame.pdf

[Shulman and Raffel, 2008] M.H.Shulman and G.Raffel. *On the oldest photons phenomenon*. Available at:
http://www.timeorigin21.narod.ru/eng_time/Oldest_photons_eng.pdf

[Zeldovitch, Novikoff, 1975] Zeldovitch J.B., Novikoff I.D. *The Universe structure and evolution.* Moscow, Nauka, 1975 (in Russian).

APPENDIX 2. Kozyrev's time

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(Updated 09.09.2009)

Starting from Kozyrev's idea about the time currency I propose a new cosmological model. In it the time currency is due to the Universe expanding phenomena. The new concept implies the correctness of the Kozyrev's hypothesis that "time transforms to the star energy".

1. Introduction

N.A. Kozyrev overcame the unbelievable difficulties of an individual human being and of discovery route ones. I believe, all of us should admire him.

I knew the Kozyrev's ideas since 19991, when the collection of his selected works was published by Leningrad State University. I had not being interested in his "causal mechanics", but his very important idea on the time *currency* that he has clearly stressed induced my own reflections over a long period of time. Besides, I was surprised by his thesis about the "time - energy" transformation. Firstly, it seemed to be only an interesting fantasy.

After several reflections I came to a new cosmological model that is just based on the universal time currency phenomenon and generalizes the Einstein's picture. But the most incredible is the fact that this new model, which does not have any common with the Kozyrev's "causal mechanics" leads very naturally the "time - energy" transformation that may be presented in the simple quantitative form.

I would like to present shortly here these two interconnected concepts. The formulas and details one may find on my site http://www.timeorigin21.narod.ru/eng_time

The book short presentation:
- *Paradoxes, Logics, and Physical Nature of Time.*

Papers:
- *Usual collapse and unusual one*.
- *On the supernovae low luminosity problem*.
- *On an experimental validation of the selected reference frame existence in the Universe.*
- *Cosmology: a New Approach*.
- *Special Relativity and Universe Evolution*.
- *Einstein, cosmological constant, and gravitational forces.*

2. Time and our Universe

The proposed new cosmological concepts is based on the Kozyrev's thesis about the universal time currency. This idea was known before him, but Kozyrev transformed it to the completely realistic form, presented it as a working apparatus. It became clearly that time should be describe not only with extension (like space), but also with especial independent attribute which Kozyrev called "the time currency".

The next step consisted in a such universal base searching, that might generate the universal time currency. The Universe expanding process is considered as such step. The commonly accepted cosmological concept allows many different possible time dependences on the Universe size, it allows also as well a uniform expanding as an accelerated or decelerated one. Contrary, the proposed model says that the only Universe current size is the unique "marker" of the Universe current age which is always exactly proportional to this size (the velocity of light is natural empirical scale coefficient).

At the first sight, the new presentation distinctly contradict to the commonly accepted one. However, I showed (as I hope) that this new ideas generalize the Einstein's ones and eliminate several mistakes. I would like here to overview shortly two important problems only, the first one is experimental, another is theoretical one.

The modern astrophysics had recently discovered *the Supernovae low luminosity phenomenon*. The scientific community believes that this phenomenon should be explained using the model, which contains the Einstein's famous cosmological constant. The value of this constant one carefully fits in order to have the optimal concordance with the experimental results. Such explanation requires that some acceleration of the Universe expanding must by present in our epoch. However, two difficulties appears. The first one consists in explanation why the modern epoch should be some especial one. The second difficulty is more important and seems to be unsolvable, it is connected with enormous energy that should be due to the cosmological constant value. Meanwhile, I showed that the *linear* connection between the Universe size and age eliminates successfully all the theoretical difficulties. Also, such model solves efficiently the complete set of the known cosmological problems (flatness, horizon, cosmological constant, CMBR dipole anisotropy, Supernovae low luminosity). Of course, any irregularity of the Universe expanding as an experimental fact is disavowed.

On the other hand, several theoretical doubts might appear because the known solutions of the Einstein-Friedmann's cosmological model equations lead generally to the *nonlinear* correspondence between the Universe size and age (if any matter is present in it). Before all, this fact is related with matter presentation as some "galactic dust". In such picture one neglects *the static matter pressure*. However, I showed that this hypothesis violates in principle the situation, although this pressure is really very small. The proof is based on the analysis of the known Schwarzshild's solution for an uniform material sphere **[Tolman, 1934]** in the case of the gravitational collapse of this sphere (by the way, I found out some non-trivial results for a boundary collapse). Finally, two new class of the Einstein-Friedmann's equations solutions was revealed – stationary and linear ones. These solutions has the next fundamental distinctions 1) the current matter density is *always* equal to so called "critical" density value *multiplied by two*, and 2) the cosmological constant does not needed even for the stationary solution, although Einstein introduced this constant in order to obtain the such solution existence. The revealed solutions "joint" very well with the above mentionted Schwarzshild's solution, and eliminate the "dark energy" problem.

3. Time and energy

But it is not all. The refusing to set to zero the static matter pressure led to the more "heretic" step – the refusing the Universe mass and energy conservation law as an absolute principle during the all its evolution. As it is known, this principle just leads to an nonlinear correspondence between the Universe size and age. In our model this correspondence is linear, and mass linearly *increases* with time.

I has to say, this conservation law became some kind of "a sacred cow" for physicists like Euclid's fifth postulate before non-Euclidean geometries discovery. Meanwhile, the energy conservation law is not an axiom, it presents a consequence from the time uniformity condition (the E. Noether's theorem) and it may be correct only if this condition was accomplished. Particularly, as well classical mechanics as quantum field theory deduce the energy conservation law from the corresponding motion equations. However, I doubt whether time during the Universe evolution may be considered as uniform one. In fact, at the early stage the space curvature was very high, whereas now it is close to zero. But physics is very strongly connected with the Universe geometry, for example, the fundamental metric tensor may be directly written through the curvature tensor components. I have several reasons to think that other most important physical quantities (i. g. Planck constant) change with the Universe age too. Because of that we have to refuse the statement relative to the exact global time uniformity, and, hence, relative to the strong accomplishment of the Universe energy and mass conservation law. By the way, this law is continuously discussed in the Gravity theory.

Here we will turn to the Kozyrev's idea relative to the "time-energy transformation". In the proposed cosmological model a star energy **E** and mass **m** relative increment is equal to a relative Universe age **t** increment:

$$\Delta m/m = \Delta E/E = \Delta t / t.$$

An additional energy evaluation follows from here that may provide the radiation power per star mass unit (**H** is here the Hubble constant, **c** is the velocity of light):

$$\Delta E/(\Delta t \cdot m) \le c^2 \cdot H$$

Particularly, the Sun relative mass decrement per year (due to the radiation) is equal approximately 10^{-13}, whereas the Universe current age may provide the relative mass increment per year up to 10^{-10}. Note, this phenomena is important for big mass like stars, for usual macroobjects any deviation from the mass conservation law is negligeable in our epoch.

However, I should note that proposed model may add a little "spoon of honey" for a conservation law followers in this "energy story". Our new model allows treat the Universe expanding process as a process of the birth and evolution of a black whole in some external super-universe, from which a matter and radiation flow over into our Universe. Hence, the hypothesis about their summary conservation (over both the universes) may be considered.

I would like to thank warmly the chairman of the Russian Interdisciplinary Temporology Seminar PhD A. Levich for his many-year support and constant goodwill.

Bibliography

[Tolman, 1934] R.C.Tolman. *Relativity, Thermodynamics, and Cosmology.* Oxford, Clarendon Press, 1934.

APPENDIX 3. Usual collapse and unusual one

(Updated: December 28, 2009)

Some phenomena emerging while one approaches immediately to the collapse of a sphere that has a finite size and consists in perfect fluid are considered.

1. Introduction

An analyzis of the gravitational collapse is often based on the assumption that a collapsing object has a real size (much) less than its gravitational radius (i.e. is considered as a material point). This can lead to the loss of several important and very interesting details and may become inapplicable.

We use the Schwarzschild's solution for the material uniform sphere problem **[Tolman, 1934]**. Such a sphere has a radius $r_1$and a density ρ, and consists in perfect fluid. The analytical description is represented in the Appendix while the main text uses the graphical dependencies on a current radius r. The dependencies are specified by a curvature radius R (or by a corresponding density value) as parameter.

.

2. Evolution of the metric tensor component G_{00}

In the General Relativity (GR) the metric tensor component G_{00} is like to the gravitation potential in the Newton's gravitation theory. Let us consider this dimensionless quantity as it approaches to the collapse. Graphically it is presented in the range $0 \le r/r_1 \le 1.1$.

If the situation is far from the collapse (the measure is specified by a ratio R/r_1 or ρ/ρ_0), the curve increases monotonically (see Fig. 1).

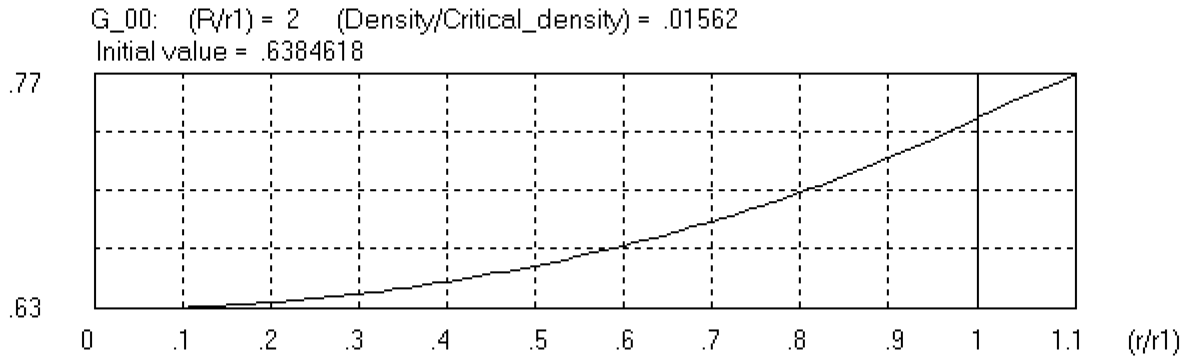


Figure 1. The distribution of G_{00} far from the collapse

However, as one approaches to the collapse (at $1 \le R/r_1 \le 3/2\sqrt{2}$) the monotonic behavior of the dependence is changing: the additional extremum appears (Fig. 2). The initial part of the curve "bulges" up having a maximum at the center of the sphere, while a new minimum appears inside of the sphere. When one approaches to the collapse, the minimum drifts to the sphere bound.

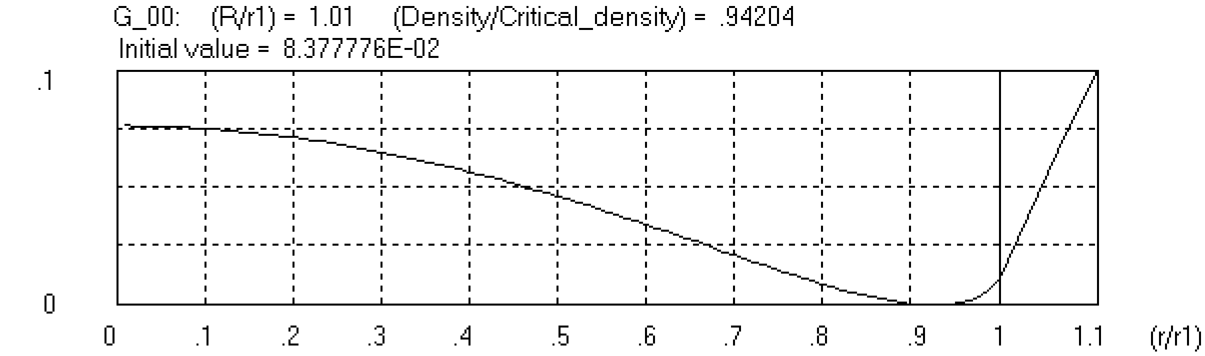


Figure 2. The distribution of G_{00} when the additional extremum appears

Finally, at the collapse state this minimum transforms to the jog localized just on the sphere bound (Fig. 3).

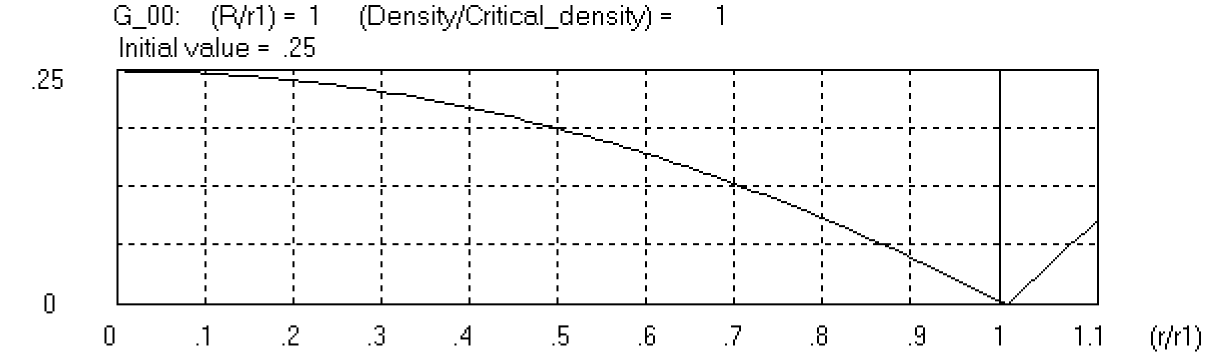


Figure 3. The distribution of G_{00} when the collapse is realized

3. Evolution of the pressure P inside the sphere

Let us consider now the pressure's behavior. It strictly positive far from the collapse and decreases down to zero monotonically from the center of the sphere to the bound (Fig. 4).

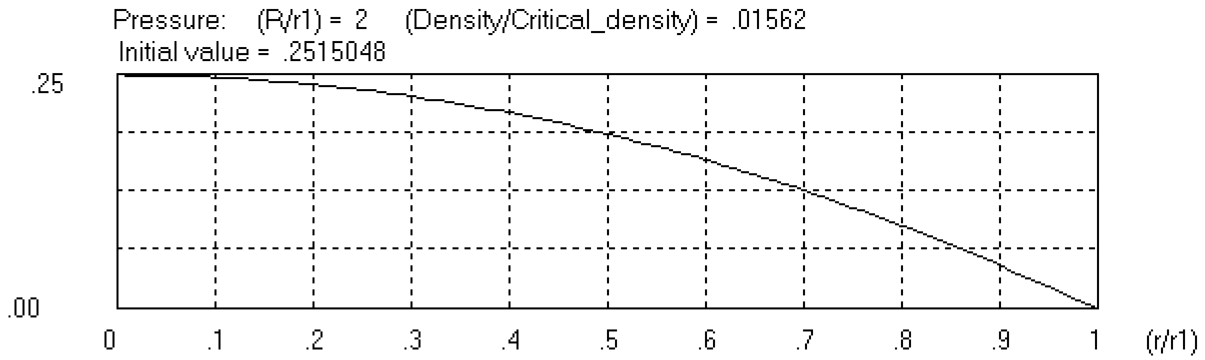
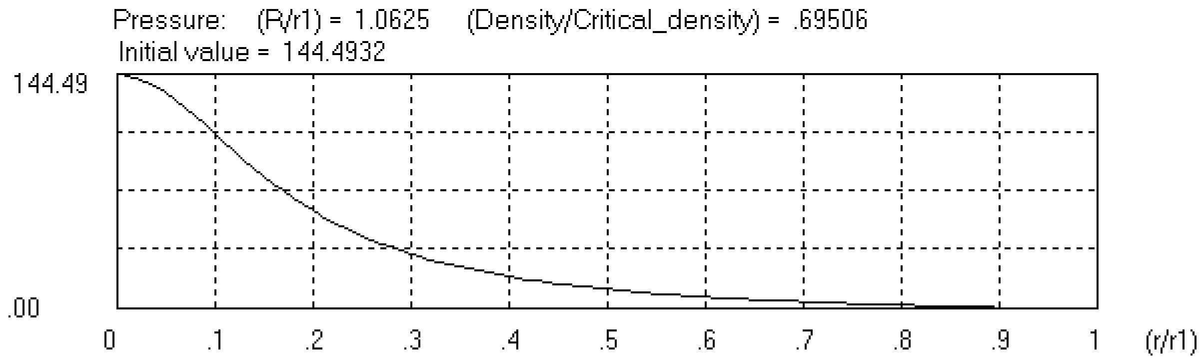
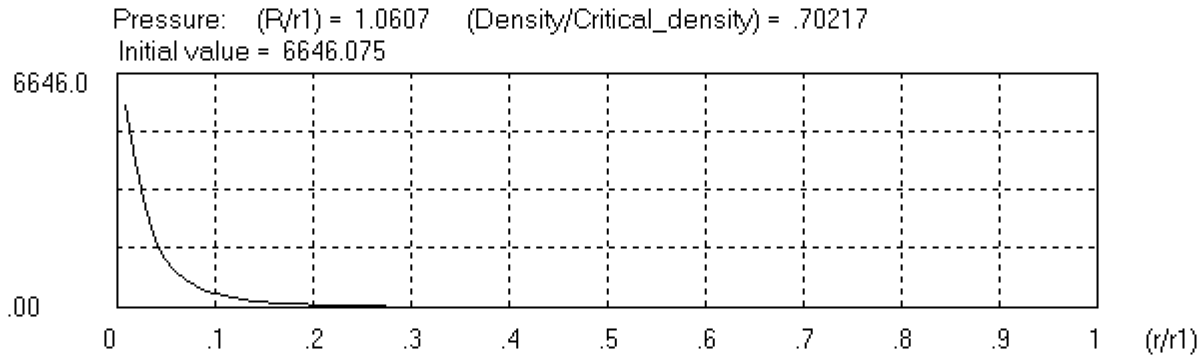


Figure 4. The distribution of the pressure far from the collapse

As well as one approaches to the domain of the additional extremum component G_{00} existing the pressure distribution irregularity increases as it was "flattened" at the central region of the sphere (Figs. 5a and 5b).



a)



b)

Figure 5. The distribution of the pressure near collapse when one extremum (minimum) of the G_{00} exists only

The very different situation is observed more close to the collapse after appearing the second G_{00}'s extremum, i.e., at $3/2\sqrt{2}>(R/r_1)>1$. The "unidirectional pulse" of the pressure having a finite value transforms to the bidirectional break of the function, its left side (before the break) becomes to be negative, while the right side (after the break) becomes to be positive (fig. 6a). At the break point the function value is not defined (the value is $\pm\infty$).

So, yet before collapse, but near its boundary $R/r_1 = 1$, we observe a new phenomenon, which consists in negative pressure. This one does not represent something unknown for physics. A pressure is positive at usual conditions, i.e. it is directed as a body was "compressed" and hence is going to enlarge. However, it is not obligatory, a body may also be in a state with a negative pressure. In such a state a body seems to be "extended" and going to compress. For example, a superheated liquid can be at a negative pressure; such a liquid operates to its boundary surface with a force directed inside of its volume. In our case the negative pressure may be due to a volume "enlarging", because the metrics changes.

In this range of conditions, while one approaches to the collapse mode the break point position is clearly shifting to the bound of the sphere from its center. The initial pressure is negative and approaches to the value –3, and the bound pressure is always zero. At the collapse mode ($R/r_1 = 1$) the pressure at the sphere bound becomes to be unidentified (0/0).

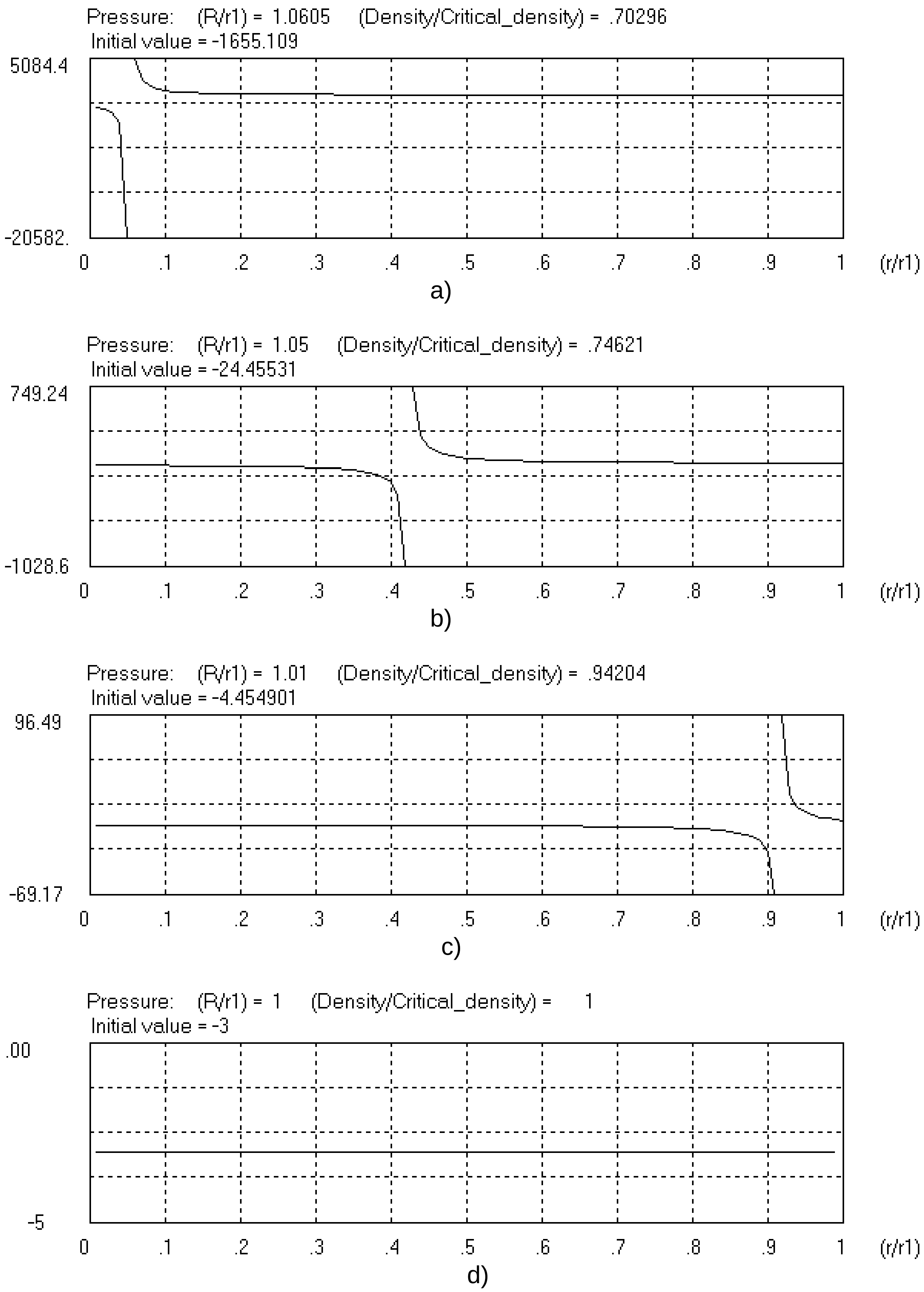


Figure 6. The transition from a finite unidirectional pressure pulse to the non-continuous behavior after the second extremum (minimum) of the component G_{00} appears. The shifting of the pressure break point to the sphere bound while one approaches to the collapse mode.

4. Conclusion

In the present work we have seen that the collapsing object real size account allows us to reveal some new and important details of this physical phenomenon. Particularly, when a real body size is a little more than its gravitational radius, the metric tensor component G_{00} plot gets the additional extremum that transforms to the to the jog localized just on the sphere bound when the both sizes become equal. The pressure remainds to be zero outside from the sphere and close to the collapse obtains an infite bipolar rupture. While one approaches to the collapse condition, this rupture is displacing beyond the sphere bounds.

It should be noted that the matter pressure plays a very important role in this model while in the model of a point mass collapse one does not account this role at all. This difference is important when one analyzes the cosmological problem (see **[Shulman, 2007]** and **[Shulman, 2006]**).

Appendix

1. Basic Relationships

The book **[Tolman, 1934]** describes the Einstein's equation solution that was found by Schwarzschild in the metrics

$$ds^2 = G_{00}\, dt^2 - r^2 (d\theta^2 + \sin^2\theta\, d\varphi^2) - dr^2 / (1 - r^2/R^2).$$

One means that a sphere consisting in the perfect fluid having a density ρ has a radius r_1 and is surrounded by an "empty" space.

The Schwarzschild's solution represents two functions: metric tensor component $G_{00}(r)$ (that corresponds to the Newton's gravitational potential) and pressure P(r). In this solution one uses the sphere radius r_1, a current radius r and the curvature radius R:

$$R^2 = 3c^2/ (8\pi G\rho)$$

Since the gravitational radius R_G of such a sphere is

$$R_G = 2GM/c^2 = 2\, (4\pi r_1^3 G\rho)/(3c^2) = r_1^3 /R^2$$

then R is univocallly connected with the gravitational radius R_G and a the sphere radius r_1 by the ralation

$$R_G/r_1 = (r_1/R)^2$$

Also, since at the collapse we have $R_G = R_G = r_1$, then

$$1 \geq (\rho/\rho_0) = R_G^2/R^2 = (r_1^6/R^6)$$

where ρ_0 is the density corresponding to the collapse (i.e. to the condition $R_G = r_1$).

The The Schwarzschild's solution is given by the dimensionless relationships

$$G_{00} = \left(\frac{3}{2}\sqrt{1 - r_1^2/R^2} - \frac{1}{2}\sqrt{1 - r^2/R^2}\right)^2$$

and

$$(P/P_0) = \Phi(r, r_1, R),$$

where $P_0 = \rho_0 c^2/3$, and the function $\Phi(r, r_1, R)$ is

$$\Phi(r, r_1, R) = \frac{3\sqrt{1-(r/R)^2} - 3\sqrt{1-(r_1/R)^2}}{3\sqrt{1-(r_1/R)^2} - \sqrt{1-(r/R)^2}}$$

2. Specification of the evolution of $G_{00}(r, r_1, R)$

It is easy to see that G_{00} is always non-negative and its initial is determined by

$$G_{00}\,(r_1 = 0) = 9(1 - r_1^2/R^2)\,/\,4$$

Furthermore, its derivative is equal to:

$$(dG_{00}/dr) = \left(\frac{3}{2}\sqrt{1-r_1^2/R^2} - \frac{1}{2}\sqrt{1-r^2/R^2}\right) r\,/\,(2R^2\sqrt{1-r^2/R^2}\,)$$

At $r = 0$ we have $(dG_{00}/dr) = 0$, and at $r = r_1$ (more precisely, at $r = r_1 - 0$) we find

$$(dG_{00}/dr) = r_1/R^2$$

It is well known that there exists usually one extremum (minimum at $r = 0$) of the function $G_{00}(R/r_1)$. However, it turns out that *before* collapse the function behavior changes, and the additional extremum appears. In fact, the equation $(dG_{00}/dr) = 0$ is equivalent to the condition

$$9(1 - r_1^2/R^2) = 1 - r^2/R^2$$

or

$$r/R = \sqrt{9r_1^2/R^2 - 8}\,.$$

Hence, the additional real extremum appears in the condition range

$$3/2\sqrt{2} > (R/r_1) > 1$$

In this case the second internal extremum becomes to be mimimum, and the first minimum at $r = 0$ is now the local minimum. This internal minimum[13] transforms at the collapse to the jog of G_{00} localized just on the sphere bound, when the derivative changes its sign, i.e., $(dG_{00}/dr) = - r_1/R^2$. Really, in the external region the expressions under all radicals will become negative ones, so finally the derivative will be multiplied by the imaginary unit square (–1).

The initial value (at $r = 0$) of the component G_{00} is always

$$G_{00\ \mathrm{init}} = \left(\frac{3}{2}\sqrt{1-r_1^2/R^2} - \frac{1}{2}\right)^2$$

and a boundary one (at $r = r_1$) is

$$G_{00\ \mathrm{bound}} = 1 - r_1/R$$

3. Specification of the evolution of $P(r, r_1, R)$

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[13] It is interesting to compare this fact with the statement from **[Novikov and Frolov, 1989]**: “The condition $r = 3R_G$ corresponds to the critical circular orbit that separates a stable motion from an unstable one. … At this the system energy is $E = \sqrt{8/9}$ …”

In order to analyze the function Φ(r) behavior it is suitable to represent it in a more compact form

$$\Phi = 3(x - z)/(3z - x) = - 3(x - z)/(x - 3z),$$

where x is first radical of the numerator depending on the variable (r/R), and z is second radical depending on the parameter (r_1/R) which indicates a distance from the collapse. The function Φ sign depends on the relation between x and z:

relation between x and z	Sign of Φ
0 < x < z	Φ (x) < 0
z < x < 3z	Φ (x) > 0
x > 3z	Φ (x) > 0

Clearly, there is the rupture of the function Φ(r) at the point x = 3z: the function has the infinite values of the opposite sign at different sides of this point. This rupture point position (r/R) is determined by the condition

$$9(1 - r_1^2/R^2) = 1 - r^2/R^2$$

i.e., by the known condition

$$r/R = \sqrt{9r_1^2/R^2 - 8},$$

that leads to the additional extremum of G_{00} existence.

The initial value (at r = 0) of the pressure P is always

$$\Phi_{init}(r, r_1, R) = \frac{3 - 3\sqrt{1-(r_1/R)^2}}{3\sqrt{1-(r_1/R)^2} - 1}$$

and a boundary one (at r = r_1) is

$$\Phi_{bound}(r, r_1, R) = \frac{3\sqrt{1-(r_1/R)^2} - 3\sqrt{1-(r_1/R)^2}}{3\sqrt{1-(r_1/R)^2} - \sqrt{1-(r_1/R)^2}} = \frac{0}{2\sqrt{1-(r_1/R)^2}} = 0$$

References

[Novikov and Frolov, 1989] Novikov I.D., Frolov V.P. *Physics of Black Holes*. Dordrecht: Kluwer Acad., 1989.

[Tolman, 1934] R.C.Tolman. *Relativity, Thermodynamics, and Cosmology.* Oxford, Clarendon Press, 1934.

[Shulman, 2006] M.H. Shulman. Paradoxes, Logics, and Physical Nature of Time. Available at: http://www.timeorigin21.narod.ru/rus_time/Origin.pdf (in Russian)**,** http://www.timeorigin21.narod.ru/eng_time/Eng_paradoksy.pdf (shortly)

[Shulman, 2007] M.H. Shulman. Cosmology: a New Approach. Available at: http://www.timeorigin21.narod.ru/eng_time/Cosmology.pdf

APPENDIX 4. Universe expansion and main spectral peak of CMB

© Michael H. Shulman, 2010 (shulman@dol.ru)

(June 06, 2010. Updated: July 03, 2010)

The standard cosmological model states that the observed data confirms the Universe curvature absence, hence its total matter density ρ equals to the critical value ρ_0. In the paper I point out that the data can be satisfactory interpreted independently of a spatial metrics type, so an alternative cosmological model having another (e.g., spherical and closed) metrics type may be considered.

1. Introduction

As it is well known, the standard cosmological model (SCM) explains the CMBR temperature fluctuations power spectrum highest peak location at ℓ ≈ 200 (that corresponds to the angular size near 1°) using flat metrics type of the Universe geometry. The part of such fluctuations is shown in Fig. 1, the total spectrum is shown in Fig. 2.

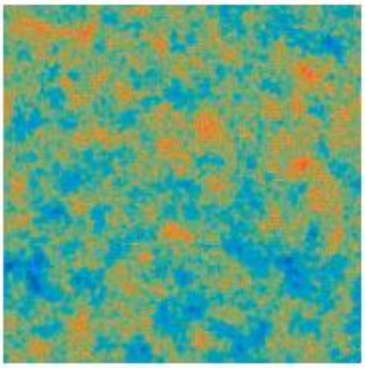

Figure 1(**[Wayne Hu, 2008]**) The part of the temperature fluctuations map

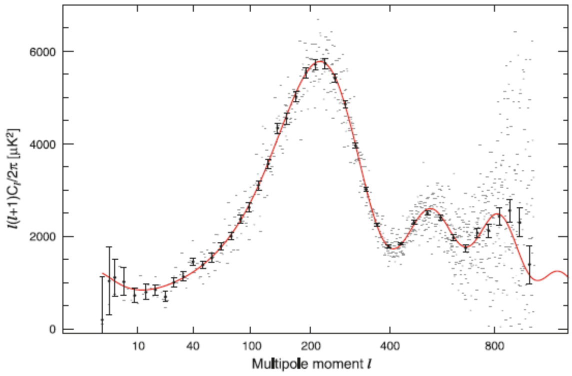

Figure 2 (**[Dunkley et al., 2008]**). The power spectrum of the CMBR temperature fluctuations

Let us consider how SCM determines the needed values of the angle and multipole number ℓ (see, e.g., **[Bersanelli et al., 2002]**, **[Dunkley et al., 2008]**, **[Samtleben et al., 2008]**, **[Spergel et al., 2003]**, **[Wayne Hu, 2008]**):

- The angle's tangent is equal to the ratio where the numerator is the size of an object and the denominator is the photon travel distance from the object to the observer. If this ratio is small enough, then the angle is near to this ratio.
- The size s_r of the area is calculated using some complicate physical process model that extends from Big Bang at t=0 (z=∞) up to last scattering epoch t_r ($z_r=1.1\cdot10^3$). As we talk about the *first* fluctuation harmonic, we can assume that s_r has simply the order of the Universe size in the last scattering epoch (at $t=t_r$).
- The photon travel distance $c\Delta t$ is proportional to the time interval between t=0 (z=∞) and $t=t_r$ ($z=z_r$). We have neglect the interval preceding t_r, so we can set $d_M=c\Delta t\approx ct_0$, where d_M is so-called metrical (coordinate) distance
- In fact, in this case one should use the angular diameter distance $d_A = d_M/(1+z)$, that takes into account the Universe expanding between photons emission and registration time points. Because of that we have to multiply the angle by the factor (1+z):

$$\Theta = (s_r/\sqrt{3})/d_M = (1+z)\, ct_r / (\sqrt{3}c\Delta t) \approx$$
$$\approx (1.1\cdot 10^3\cdot 3.3\cdot 10^5) / (1.7\cdot 13.7\cdot 10^9) =$$
$$= (3.6/2.4)\cdot 10^{-2} = 1.5\cdot 10^{-2} \text{ radians} = 0.9°$$

(here the factor √3 is due to the relation between amplitudes of the gravitation potential fluctuation and temperature fluctuation). The corresponding multipole number is $\ell \approx 180°/0.9° = 200$.

One can use $c\Delta t$ as the metrical (coordinate) distance only in case of the flat[14] Universe. By-turn, in the SCM the flat metrics suggests that in the Einstein-Friedmann equations one has uses the matter density ρ equal to the so-called critical value ρ_0. And finally, as it is well known, in the SCM the relation between ρ and ρ_0 determines not only the *spatial* metrics type, but also the type of the Universe *time evolution*.

2. Alternative way to calculate the main CMBR spectral peak location

However, there exists another way to calculate the location of the CMBR temperature fluctuations power spectrum maximal peak that is not connected at all with the hypothesis of the flat Universe spatial metrics. This way is very simple, it consists in the follow: at the epoch of last scattering the sound horizon encircled completely an imaginary observer. After this epoch the basic wavelength ($\sim s_r$) remains constant while the Universe scale factor becomes larger with the factor (z+1). Hence, the multiplication factor for this harmonic of fluctuation for modern observer will be equal $(z_r+1)/\sqrt{3}$ (see the above remark). So, we get the angle value $\theta \approx 0.6°$ at z=1100 as it is exactly confirmed by the last observations data[15].

3. Alternative model of the Universe evolution

Since 1993 I develop an alternative cosmological model (see **[Shulman, 2007a]**). I called it the Spherical Expanding Universe Theory (SEUT). It considers our Universe as a black hole in some external super-Universe (such a possibility was discussed by the famous physicist J. Wheeler, see **[Smolin, 1994]**). If one neglects by the "quantum evaporation", then the matter and energy absorption by the black hole presents an *irreversible* process. Due to it the expansion of our Universe happens. If one supposes also that the Universe total electric charge and angular momentum are zero, then its increasing mass will be strongly proportional to its gravitational radius. Furthermore, this mass (from physical point of view) will be a single parameter "marking" the black hole states. It is a reason to introduce a "parametric" time that is (by definition) proportional to the mass and (as a consequence) to the size. For an "external" observer the parametric time will increment (just proportionally) *only when* the black hole mass will increase.

Let us write the standard Einstein-Friedmann's equations in such the Universe for an "internal" observer, where usual time is replaced by just such "parametric" time. Note, in this model we should not use the mass-energy conservation law, because the mass increases continuously (however, in the present epoch the relative error is not more than 10^{-10} per year). Instead of this boundary condition one should use another one: the postulated proportionality between the Universe size and age. In such the solution any *expansion type* dependence on a *spatial metrics type* is eliminated in principle. As we could see, this does not lead to real contradiction with the observed data.

[14] In other cases, as it is well known, an additional factor appears that contains sin (closed geometry) or sinh (open geometry).

[15] In the last WMAP's report **[Komatsu et al., 2010]** the value θ=0.6° is pointed out.

Is the parametric time a convenient mathematical abstraction only? Does there exist an objective base to percept this time by the different internal observers? I propose the following answer: the space and time extent are perceived by each quantum object because it has own “rod” and “clock”, i.e., the length and period of proper de Broglie wave. Thus, the universal and irreversible Time currency appears objectively for all observers as well as the estimates of temporal and spatial intervals.

4. Comparison between models

Let us consider three simplest model of the cosmological evolution that are present in the Fig. 3 as the cones. The top of each cone corresponds to the Big Bang, while the bottom base corresponds to the *current* spatial cross-section, i.e., to the simplified Universe picture at the present-day epoch. The time axis is directed in Fig. 3 downward along the *generatrix* of cone (meridian), while the parallels correspond to some spatial instantaneous states of the Universe.

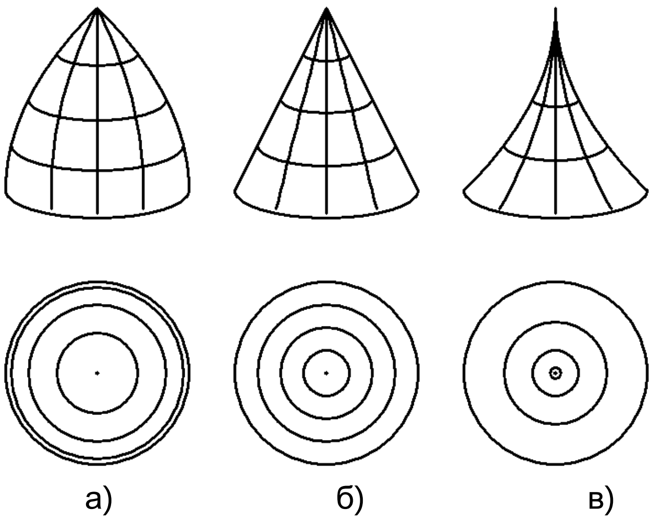

Figure 3.
The geometrical representation of the expanding Universe
(a) the decelerating expansion
(b) the uniform expansion
(c) the accelerating expansion

For all tree model in our Figure the Universe is depicted as simple *closed* circumference. In the SEUT this means that at each time point the expanding Universe (*independently* on a model or a *value* of ρ) is a volume closed on itself 3D, i.e., a finite 3D non-Euclidean hypersurface of the 4D-cone. When one considers a spatial-temporal cross-section of the cone including its generatrix, he may talk about different Universe evolution models that in the SCM *depend* on the relation between ρ и ρ_0 (see **[Palash, 1999]**). The corresponding non-uniformity of the Universe expansion is shown in three lower pictures of the Fig. 3.

Fig. 4 shows two laws of the Universe scale factor (a/a_0) evolution depending on the dimensionless age H_0t (where H_0 is the Hubble parameter in our epoch), see details in **[Shulman and Raffel, 2008]**. The red line corresponds to the exactly linear evolution law (SEUT), when the scale factor is exactly proportional to the Universe Age (linear generatrix of the evolution cone in Fig.3). The blue curve corresponds to the SCM approach, or ΛCDM-model (Ω_M = 0.25, Ω_L = 0.75, Ω_k = 0). In this case the cone generatrix grows with an *alternating acceleration sign* (not the case of Fig. 3).

Using a fitting of the “best” value of Ω_M, Ω_L, and Ω_k for such a law, SCM concludes that in our epoch the Universe expands with acceleration. However, the SEUT leads to another conclusion: the blue curve’s parameters are selected to be having the same final point as the red line that provides the constant rate of the Universe expansion.

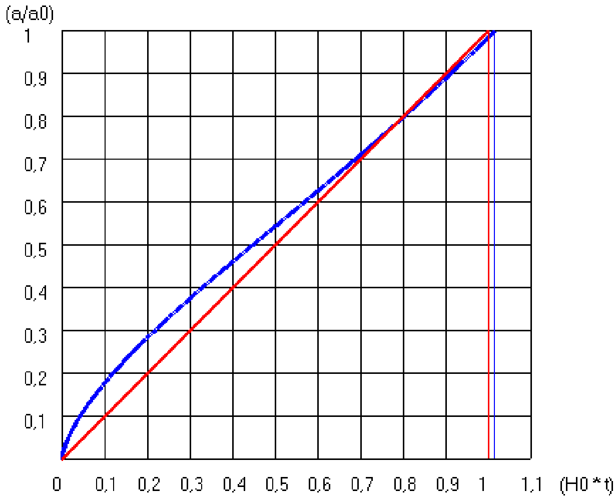

Figure 4

ΛCDM-model (Ω_M = 0.25, Ω_L = 0.75, Ω_k = 0)
linear model (SEUT)

We should note the SCM cannot overcome several fundamental problems (particularly, Λ and vacuum energy problem), while these problems are effectively interpreted in the SEUT (see **[Shulman, 2007b]**) without any “fitting”. Finally, SEUT explains the temperature spectral peak existing at ℓ = 4 – 5 (while SCM have not any explanations), and made also another new predictions (see **[Shulman and Raffel, 2008]**).

I have to add that there appear new publications on the linear connection between size and age of the Universe (see **[Kronov]**, **[Barak and Leibowitz, 2009]**, **[Benoit-Levy and Chardin, 2009]**, **[Farley, 2010]**).

References:

[Barak and Leibowitz, 2009] Shlomo Barak and Elia M Leibowitz. Cosmology and Astrophysics without Dark Energy and Dark Matter. ArXiv: astro-ph 0909.2581 v1, Submitted 14 September 2009

[Benoit-Levy and Chardin, 2009] Aurelien Benoit-Levy and Gabriel Chardin. Do we live in a Dirac-Milne Universe? ArXiv:0903.2446v1 [astro-ph.CO] 13 Mar 2009.

[Bersanelli et al., 2002] Bersanelli, D. Maino and Mennella. Anisotropies of the Cosmic Microwave Background. arXiv:astro-ph/0209215 v2 27 Sep 2002].

[Dunkley et al., 2008] Dunkley et al. Five-Year Wilkinson Microwave Anizotropy Probe (WMAP) Observations: Likelihoods and Parameters from the WMAP data. ArXiv:astro-ph/0803.0586v1 5 Mar 2008

[Farley, 2010] Francis J.M. Farley. Does gravity operate between galaxies? Observational evidence re-examined. ArXiv:1005.5052v1 [astro-ph.CO] 27 May 2010

[Komatsu et al., 2010] Komatsu et al. Seven-Year Wilkinson Microwave Anisotropy Probe (WMAP) Observations: Cosmological Interpretation. ArXiv: 1001.4538v2 [astro-ph.CO] 12 Feb 2010

[Kronov] Kronov N.A. http://n-kronov.chat.ru/ (in Russian)

[Palash, 1999] Palash B. Pal. *Determination of cosmological parameters: an introduction for non-specialists.* arXiv:hep-ph/9906447 v1 22 Jun 1999.

[Samtleben et al., 2008] Dorothea Samtleben, Suzanne Staggs and Bruce Winstein. The Cosmic Microwave Background for Pedestrians: A Review for Particle and Nuclear Physicists, arXiv:0803.0834v1 [astro-ph] 6 Mar 2008

[Shulman, 2007a] M.H. Shulman. Cosmology: a New Approach. Available at: http://www.timeorigin21.narod.ru/eng_time/Cosmology.pdf

[Shulman, 2007b] M.H. Shulman. On the supernovae low luminosity problem. 2007. Available at: http://www.timeorigin21.narod.ru/eng_time/On_supernovae.pdf

[Shulman and Raffel, 2008] M.H. Shulman, G.A. Raffel. On the Oldest Photons Phenomenon. Available at: http://www.timeorigin21.narod.ru/eng_time/Oldest_photons_eng.pdf

[Smolin, 1994] Lee Smolin. The fate of black hole singularities and the parameters of the standard models of particle physics and cosmology. ArXiv:gr-qc/9404011v1 7 Apr 1994

[Spergel et al., 2003] D. N. Spergel et al. First Year Wilkinson Microwave Anisotropy Probe (WMAP) Observations: Determination of Cosmological Parameters. ArXiv: astro-ph/0302209v3

[Wayne Hu, 2008] Wayne Hu. Lecture Notes on CMB Theory: From Nucleosynthesis to Recombination. arXiv:0802.3688v1 [astro-ph] 25 Feb 2008

APPENDIX 5. On the preferred reference frame existence in the Universe

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(Updated: May 22, 2014)

1. The dipole anisotropy of the cosmic microwave background radiation

In 1964th Arno Penzias and Robert Wilson were performing a careful calibration of their radio telescope at the Bell Laboratory at Whippany, New Jersey. They found that their receiver reached a "noise" pattern as if it was inside a container whose temperature was near to 3 K - i.e. as if it was in equilibrium with a black body at 3 K. This "noise" seemed to be coming from all directions. In 1978th Penzias and Wilson have got the Nobel prize in physics for this discovery. This radiation was identified as cosmic microwave background radiation (CMBR) and supposed to be connected with the Universe early process. Accordingly to the last data this radiation corresponds to a black body radiation at 2.72548±0.00057 K with the peak at 160.2 HHz (wavelength is 1.063 mm). The radiation is isotropic to roughly one part in 100,000: the root mean square variations are only 18 μK, after subtracting out a dipole anisotropy from the Doppler shift of the background radiation. The CMB's redshift is a little more than 1000.

A black body at such the temperature emits most of its energy in the microwave wavelength range. Molecules in the earth's atmosphere absorb this radiation therefore astronomers cannot make observations from the ground in this wavelength region. So, these measurements were executed firstly from the stratosphere using planes and balloons and then from the open space using satellites. When cosmologists first looked for the microwave sky (several decades ago), they noticed it was nearly uniform.

However, as observations improved, they detected the *dipole anisotropy*. The noted Russian scientist Ya.B. Zeldovitch wrote in the Editorial Addition to **[Weinberg, 2000]:** "… these careful measurements allowed to find out some anisotropy of CMBR. An antenna oriented to the Lion constellation detects that the radiation temperature is 0.013% more, than mean one. The radiation temperature in the opposite direction is 0.013% less, than mean one. Generally, a temperature varies continuously between these two values[16]."

Finally, the Cosmic Background Explorer (COBE)[17] satellite that started in 1989th, surely detected several cosmological fluctuations and dipole anisotropy in the microwave background temperature. The CMBR spectrum was measured at 0.005% precision level; it was found out this radiation has essential anisotropy at relative order 10^{-5}.

The temperature deviations map is shown on the Figure 1, the mean value is 2.728 К at the microwave spectra range. The stratified map structure corresponds with the dipole anisotropy.

In addition to its infrared component the much more wide CMBR spectra range was studied. Starting since 1990th the X-radiation and gamma-radiation are studied with help of several sattelites. The X-radiation observable dipole anisotropy just corresponds with background 3К-radiation (see for **[Klapdor-Kleingrothaus, Zuber, 1997]**). The common explication of this effect consists in the Solar system motion with velocity 369 ± 0.9 km/s to the point (l, b) = (264°,48°) on the sky.

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[16] My own translation.
[17] The information presented by Goddard Space Flight Center, NASA, USA (COBE Science Working Group, NSSDC).

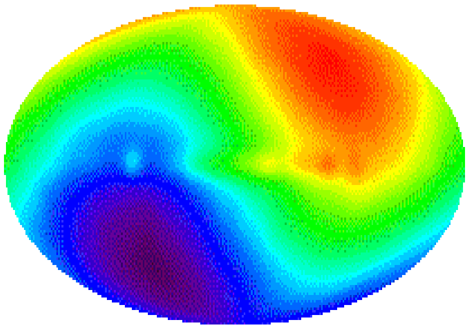

Figure 1. The CMBR temperature dipole anisotropy

2. The radiation anisotropy and the preferred reference frame

The Michelson and Morley's experiments and the Einstein's Special Relativity proved that any preferred inertial reference frame couldn't exist as well as any ether does not exist where electromagnetic waves may propagate. So, at the border between the 19th and the 20th centuries the absolute space concept seemed to be rejected forever.

However, the Solar system motion corresponding with the CMBR dipole anisotropy has an absolute character. As Ya.B. Zeldovitch continues in **[Weinberg, 2000]**:

"The isotropy presents only for some imaginary observer. *The Solar system, Earth move to the Lion constellation relative to this observer having velocity 390 ± 60 km/s*. Hence, as a result of the Doppler effect, a meeting radiation seems to be more hot, and an overtaking radiation seems to be more cold. This example shows that an observer exists in every point of the Universe, for which a CMBR is isotropic. We may consider this observer and a connected reference frame as preferred. The preferred reference frame existence at the Universe every point looks like the physicists commonly held view preceding to Relativity. They thought that the light presents the ether oscillations occupying whole the Universe. They thought also that the reference frame connected with ether is preferable, or preferred one. They tried to detect the Earth motion relative to ether.

We know that these experiments gave the negative result: any ether doesn't exist. But the Universe evolution follows that when CMBR is observed (and only in this case!), the preferred reference frame (called sometime "new ether") appears. This new ether at one place is moving relative to new ether at other one. *The new ether or CMBR just provides the motion accordingly to the Hubble's law*[18]*.*"

Ya.B. Zeldovitch himself proposed an explanation of this radiation anisotropy based on the probable early Universe anisotropy **[Zeldovitch, Novikoff, 1975]**. But I propose the more fundamental explanation. It states that any acceleration (including the rotating and oscillating ones) selects in general the absolute reference frame. Since any electromagnetic radiation is generated by oscillating electrical charges, therefore it allows in principle to an observer to select the absolute reference frame.

As I wrote in the works **[Shulman, 2006]**, **[Shulman, 2007]** an own unique direction and velocity value must exist in each point of the Universe*, that define a preferred reference frame* (in fact, that is "the 4D time arow""). I found out this results in 1997th before I knew about the CMBR dipole anisotropy discovery. Therefore, a demande to experimentally valide (or to reject) the new theory appeared.

If an observer Is absolutely immobile during the Universe expanding, then a radiation will be ideally isutropic relative him. But if the observer world line presents some non-zero angle to the absolute time axis, then such moving observer using Doppler effect can detect

[18] My own translation.

the absolute velocity of its motion. For this he must detect that radiation anisotropy, due to the direction and velocity of a meaurement device relative to the absolute reference frame. Quantitatively this anisotropy will depend on the value (in fact, v/c~0.0015) and on the angle α related to the preferred motion direction, as Doppler effect theory predicts.

In the previous version of the paper I supposed to use the sunlight spectrum measurements at different Earth locations relative to Sun or mutually immobile system "light source – spectrum analyzer". However, two independent expert said me that such the effect should be large enough to pass unnoticedbe so far. So, I had to revisit the situation and understood that Earth together with Sun (or a proposed light source) moves relative to the absolute reference frame, so one cannot see any effect. Then I came to conclusion that it enough to use the *gedanken* experiment only! In fact, let us have a light source that is *immovable relative to CMBR*, i.e., relative to the absolute reference frame. But then this source will move relative Earth and therefore a terrestrial observer will reach its Doppler's frequency shift. In other words, each *local* radiation source will give the same effect as the *global* CMBR (the Zeldovitch's opinion).

I also belive, a purely mechanical experiments are possible too (see for. **[Shulman, 2006]**). If the Earth having some velocity moves relative to the absolutely immobile (preferred) reference frame, then one could valide this reference frame existence by measuring the force/acceleration relation along the velocity and perpendicularly to it. If that velocity is really determined by the CMBR dipole anisotropy direction and value, then we may find out the relative acceleration difference near 2,25 x 10^{-6}.

Finally, I would like to note the "new ether" preferred reference frame is connected not only with a motion to 3D direction in the Universe (like the"old ether"), but also with a 3D velocity along this direction. Summary some 4D vector (the time arrow) appears, which presents a normal one to the 4D spherical hypersurface, or to our Universe.

References

[Weinberg, 2000] Weinberg Steven. *The First Three Minutes. A Modern View of the Origin of the Universe*. See Russian Edition: Moscow, R&C Dynamics Ed., 2000 (in Russian).

[Zeldovitch, Novikoff, 1975] Zeldovitch J.B., Novikoff I.D. *The Universe structure and evolution.* Moscow, Nauka, 1975 (in Russian).

[Klapdor-Kleingrothaus, Zuber, 1997] H.V.Klapdor-Kleingrothaus, K.Zuber *Teilchenastrophysik*. B.G. Teubner GmbH, Stutgart, 1997

[Shulman, 2006] Shulman M.H. *Paradoxes, Logics, and Physical Nature of Time.* Available at: http://www.chronos.msu.ru/RREPORTS/shulman_paradoksy.pdf (in Russian)

[Shulman, 2007] Shulman M.H. *Cosmology: a new approach*. Available at: http://www.timeorigin21.narod.ru/eng_time/cosmology.pdf

APPENDIX 6. On the oldest photons phenomemon

© M.H. Shulman (shulman@dol.ru) and G.A. Raffel, 2008

(Updated: April 22, 2010)

The existence of relict photons circumnavigating the entire Universe is predicted using a new cosmological model. The CMBR correlation spectrum properties at $\ell < 10$ are explained.

1. Introduction

Starting in 1997, a new cosmological model **[Shulman, 2006, 2007a, 2007b, 2007c, 2007d]** called the Spherical Expanding Universe Theory (SEUT) has been developed. In the SEUT model, our Universe presents an expanding spherical 3D surface in a (purely Euclidean) 4D continuum. The 4D sphere's increasing radius produces the direct and exclusive measure of Time, because the Universe's age is directly proportional to the current radius. In the cited publications the theoretical background and a number of new results are considered.

The SEUT model allows us to solve a number of famous cosmological problems (maximal speed, Universe horizon and flatness, cosmological constant, CMBR dipole anisotropy) and to make some new predictions that can be compared with real astrophysical observations. Particularly, it makes it possible to describe quantitatively the low Supernovae luminosity effect without use of the cosmological constant **[Shulman, 2007c]**, which prejudices a Universal accelerated expansion in the current epoch.

This new model concept allowed one of us (G. R.) to predict one more possible phenomenon. It turns out that the "oldest" relict photons are able to make a complete "universal tour" and return to us after 13.7 billons years from the opposite side of the sky. This phenomenon may explain some properties of the CMBR spectra.

2. Effect essence

In the SEUT model any immovable body "drifts" along a radius of a 4D expanding sphere. The 3D distances between different immovable points of the spherical surface increase as the Hubble law requires, and the angle Θ between the corresponding 4D radii remains constant.

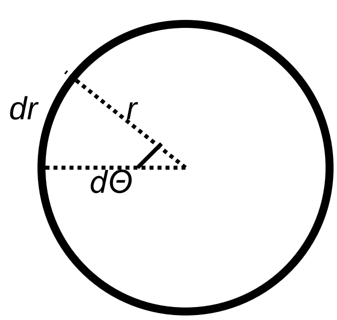

Figure 1

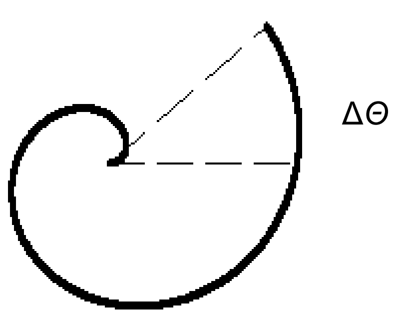

Figure 2

However, when we consider a body moving in 3D, then the angle Θ increases too. In the case of the speed of light, the moving point displacement increases by dr when the 4D radius *r* rises by *dr,* and displaces an angle $d\Theta = dr/r$ (see Fig. 1). If one calculates the integral he finds that this angle is equal to

$$\Theta = \ln (r_2 / r_1)$$

as the Universal radius changes from r_1 to r_2.

Now we are able to find the value of Θ as the Universe expanded from the last scattering surface (z ~ 1100) up to now (z = 0). This value is equal to $\ln(r_2/r_1) = 7.00$, so the "overlap" is (see Fig. 2):

$$\Delta\Theta = 7.00 - 6.28 = 0.72 \text{ (rad)},$$

or about 41º. In other words, the "oldest" photons have freely circumnavigated the entire Universe, and have returned to us from the opposite side of sky (as F. Magellan). This leads to additional photon intensity in the CMBR spectrum.

3. Effect manifestation and results discussion

Are we able to observe such effects in real existence? Modern astrophysics observes an experimental autocorrelation in the CMBR spectrum (see WMAP's data on Fig. 3). It demonstrates a correlation between temperatures of different sky areas depending on domain sizes. More precisely, this function argument is a multipole number $\ell \sim \pi/\theta$, where θ is the angular domain size. The maximal peak in Fig. 3 corresponds to ℓ ~ 200, i.e. to the modern angular size (~ 0.6º) of the last scattering surface (see Fig. 3).

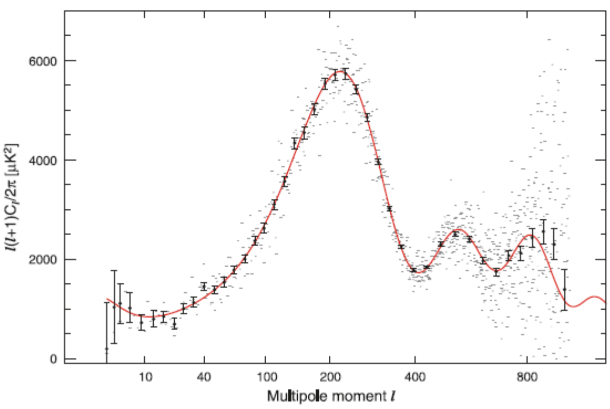

Figure 3 **[Dunkley et al., 2008]**

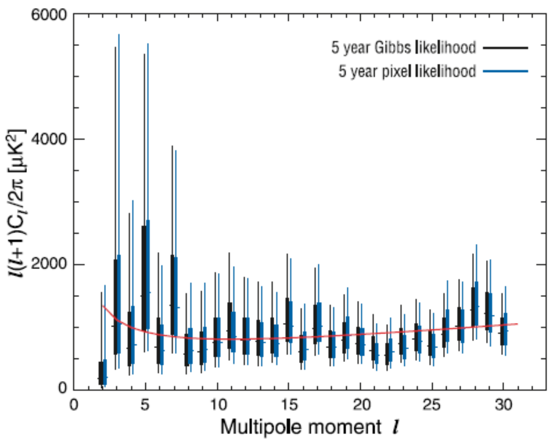

Figure 4 **[Dunkley et al., 2008]**

As it was noted above (see Fig. 2), the angular overlapping $\Delta\Theta$ for the oldest photons is up to 0.72 radians (41º). Such angular size should correspond to $\ell \sim 3.14/0.72 = 4.4$. *The theoretical dependence* at $\ell < 25$ corresponds to the so called Sachs-Wolfe Plateau and presents a flat domain. However, we see in Fig. 4 (initial part of spectrum) that the *experimental peaks* occur just at $\ell \sim 3 \div 7$ (the authors **[Dunkley et al., 2008]** present the different versions of data treatment).

In addition to the autocorrelation *temperature* spectrum there is a correlation between the temperature and E-polarization fluctuations (see the experimental WMAP data on Fig.'s 5, 6). At $\ell \sim 3 \div 9$ the plot's properties are close to those of Fig.'s 3, 4.

The theoretical predictions are shown on Fig.'s 5, 6 by continuous lines. The data publishers note that the experimental dependence essentially differs from the theoretical prediction at $\ell < 20$. One can explain this fact using the hypothesis that some ionized environment exists between the current epoch and the one at z ~ 20. However, this implies a very complicated ionization dependence on time. It was also noted that the model criterion χ^2 is very large and gives the correctness probability value not more than 3-5%.

In our opinion, the SEUT oldest photon phenomenon produces a better explanation of the CMBR correlation spectra.

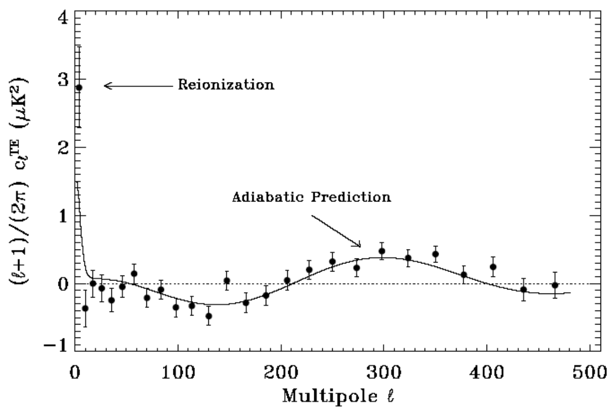

Figure 5 **[Spergel et al., 2003]**

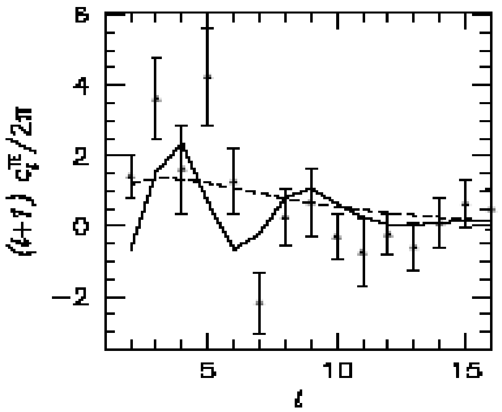

Figure 6 **[Spergel et al., 2003]**

4. Comparison with ΛCDM-models

It is instructive to compare the SEUT's predictions with the standard ΛCDM-model's ones. The latter states (see **[Palash, 1999]**), that the link between attained Universe dimensionless enlargement $y=a/a_0$ and dimensionless time H_0t after Big Bang is given by

$$H_0 t = \int_0^{y(t)} \frac{dx}{\sqrt{1+(\frac{1}{x}-1)\Omega_m+(x^2-1)\Omega_\Lambda}}$$

Here a(t) is the Universe size at a time t, index "0" denotes the actual values of the Universe size a and Hubble parameter, so $y(t_0) = 1$. The parameters Ω_m and Ω_Λ denote the fractions of the matter density and Λ-component. The results of numerical calculation are presented in the Fig. 7. As one can see, the Universe dimensionless age H_0t is also near to 1 for the ΛCDM-model at the well-known "optimal" values (Ω_Λ=0.75 and Ω_m=0.25).

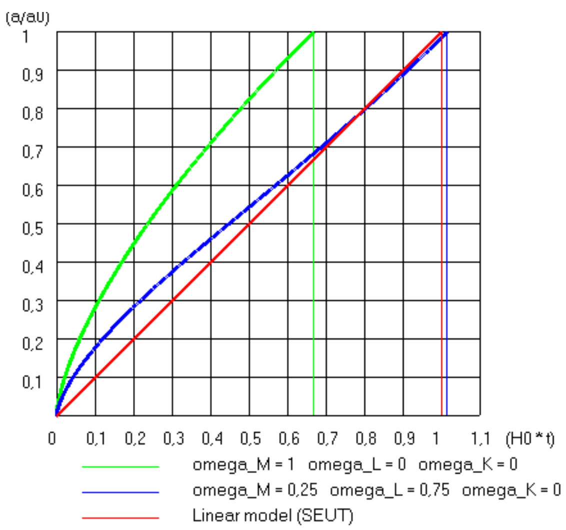

Figure 7.

On the other hand, one can present “the Universe full fly-around angle“ for any model as

$$\Theta = \int_0^t c\,d\tau / a_0 y(\tau)$$

We can approximate this integral by the sum

$$\Theta(H_0t) = (c/a_0)/H_0 \sum_0^t \; [\Delta(H_0\tau)/y(H_0\tau)],$$

where one should sum over successive (enough small) time intervals. These ones do not need to be equal one to another, it is more opportune to select the uniform steep over $y(H_0\tau)$.

The dimensionless factor preceding the sum sign contains the actual values of the Hubble parameter H_0 (that is determined by astrophysical data) and the absolute Universe size a_0. As we do not know the real value of a_0, this factor is determined by the time when the fraction (a/a_0) attains 1 at a selected cosmological model (see Fig. 7 and Table 1).

Table 1

Model	H_0t_0	$(c/a_0)/H_0$	$\Theta(H_0t_0)$, rad
SEUT	1	1	7.00
ΛCDM // $\Omega_\Lambda = 0$, $\Omega_m = 1$	0.6672	1.4988	2.93
ΛCDM // $\Omega_\Lambda = 0.75$, $\Omega_m = 0.25$	1.0143	0.9859	3.42

The results of numerical calculations of Θ (“angular” particle horizon) are shown in Fig. 8. As it easy to see, for both versions of the ΛCDM-model the angle Θ increases along the same curve (however, the domains of this curve are limited by different Universe ages).

The revealed angle values for ΛCDM-models exclude practically any possibility of the oldest photons effect manifestation in the CMBR spectrum. Only in the SEUT does the curve transverse the critical level 2π (the dotted line in Fig. 8). Note, that the large difference between SEUT and ΛCDM-models appears during the initial 10% of expansion time.

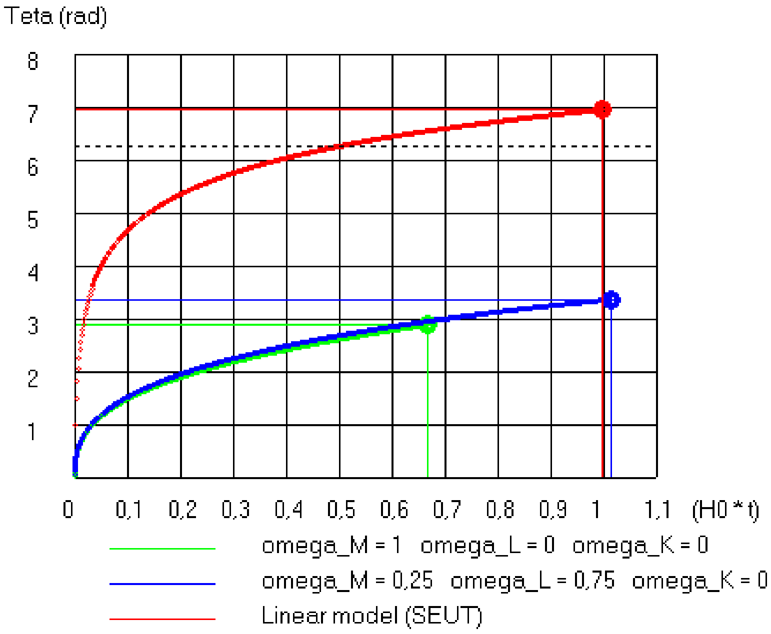

Figure 8.

References:

[Dunkley et al., 2008] Dunkley et al. Five-Year Wilkinson Microwave Anizotropy Probe (WMAP) Observations: Likelihoods and Parameters from the WMAP data. ArXiv:astro-ph/0803.0586v1 5 Mar 2008

[Palash, 1999] Palash B. Pal. *Determination of cosmological parameters: an introduction for non-specialists.* arXiv:hep-ph/9906447 v1 22 Jun 1999.

[Shulman, 2006] M.H. Shulman. *Paradoxes, Logics, and Physical Nature of Time.* Available at: http://www.timeorigin21.narod.ru/rus_time/Origin.pdf (in Russian)**,** http://www.timeorigin21.narod.ru/eng_time/Eng_paradoksy.pdf (shortly)

[Shulman, 2007a] M.H. Shulman. *Usual collapse and unusual one*. 2007. Available at: http://www.timeorigin21.narod.ru/eng_time/Collapse.pdf

[Shulman, 2007b] M.H. Shulman. *Cosmology: a New Approach*. Available at: http://www.timeorigin21.narod.ru/eng_time/Cosmology.pdf

[Shulman, 2007c] M.H. Shulman. *On the supernovae low luminosity problem*. 2007. Available at: http://www.timeorigin21.narod.ru/eng_time/On_supernovae.pdf

[Shulman, 2007d] M.H. Shulman. *On an experimental validation of the selected reference frame existence in the Universe. 2007.* Available at: http://www.timeorigin21.narod.ru/eng_time/ On_the_selected_reference_frame.pdf

[Spergel et al., 2003] D. N. Spergel et al. First Year Wilkinson Microwave Anisotropy Probe (WMAP) Observations: Determination of Cosmological Parameters. ArXiv: astro-ph/0302209v3

APPENDIX 7. On supernova low luminosity problem

(Updated: April 28, 2010)

A modification of the Einstein-Friedmann (EF) cosmological model allows to propose a new solution of several fundamental cosmological problems, in particular the supernovae low luminosity problem at redshift z > 1.The proposal excludes in principle some non-monotone (for example, accelerating) Universe expansion.

1. Introduction

As it is known, the real supernovae luminosity is lower than this one predicted by the EF-model *without* the non-zero cosmological constant. The standard approach consists in fitting of a model by choice of the corresponding constant value. The author of the publication proposed in 1997th a new cosmological model (the Spherical Expanding Universe Theory – SEUT). It is systematically described in details in **[Shulman, 2006, 2007]**. Time currency is there connected with the single global process. This process is the Universe expansion, it is external one relative to its features. In the frame of this model any non-linear Universe radius dependence on its age has not any meaning. This new concept, as the author believes, allows us to solve a number of fundamental cosmological problems **[Shulman, 2007]** including the famous one – the remote supernova low brightness problem.

In the recent works (particularly, see **[Benoit-Levy and Chardin, 2009]**) the new types of cosmology were proposed, where the *linear* Universe age dependence on its radius appears. The authors show that such linear dependence explains quantitatively the low luminosity of SN type Ia without usage of the cosmological term and allows us to resolve a number of the paradoxes of the modern cosmology.

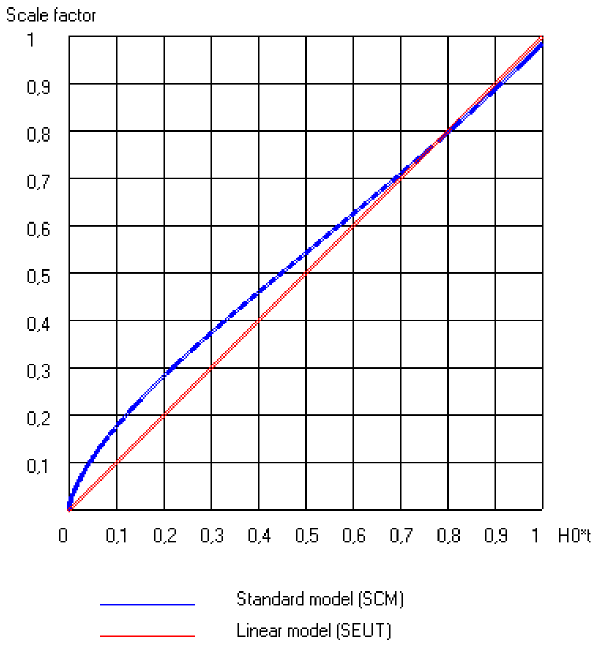

Figure 1.
Scale factor vs Universe age dependence in SCM and SEUT

The comparative dependences of the Universe scale factor evolution in the standard cosmological model (SCM) at Ω_m = 0,25, Ω_Λ= 0,75, Ω_k = 0 (blue curve) and in the SEUT (red curve) are shown in the Fig. 1. One can see that in our epoch (at small z) these curves are very close one to another.

2. Scale factor dependence on redshift

In the standard cosmology the coordinate dimensionless distance ***r(z)*** and the photometric one (or "luminosity distance") ***ℓ(z)*** between ***a*** modern observer and some emitter of the light signal at redshift ***z*** are connected (at *c* = 1) by relationship:

$$\ell(z) = H_0\, a_0\, r(z)\,(1 + z)$$

where H_0 is the Hubble constant, a_0 is the Universe scale factor (at the present epoch). The factor (1 + ***z***) in a static universe is absent, but in the expanding Universe it accounts *an evolution* of the space scale during a light propagation time. On the other hand, the factor ***r(z)*** gives through ***z*** *the distance himself*, that the light signal had to move between emitter and receiver without account of the Universe expansion as such (as it is clear, it is equal to zero at ***z*** = 0). The production $H_0a_0r(z)$ is equal in the EF-model (**[Palash, 1999]**):

$$H_0 a_0 r(z) = \frac{1}{\sqrt{|\Omega_k|}}\,\mathrm{sinn}\left[\sqrt{|\Omega_k|}\int_0^z \frac{dz'}{\sqrt{(1+z')^2(1+\Omega_m z') - z'(2+z')\Omega_\Lambda}}\right],$$

where "sinn" means the hyperbolic sine function if $\Omega_k > 0$, and sine function if $\Omega_k < 0$. If Ω_k=0, the sinn and the Ω_k disappear from the expression and we are left only with the integral. Here we use the dimensionless density components due to the matter (Ω_m), to the curvature (Ω_k), and to the cosmological constant (Ω_Λ), where $\Omega_m + \Omega_k + \Omega_\Lambda = 1$.

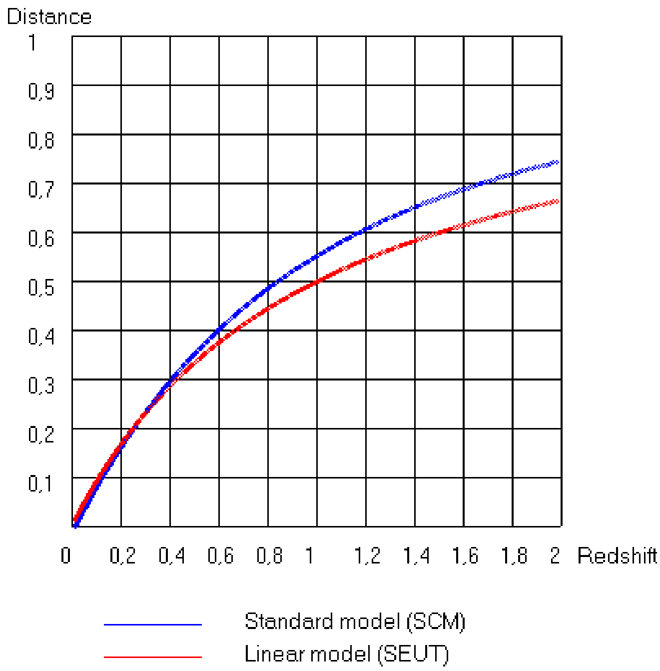

Figure 2. Dependence $H_0\, a_0\, r(z)$ vs redshift in SCM and SEUT

The numerically calculated plot $H_0a_0r(z)$ for the SCM at Ω_m = 0,25, Ω_Λ= 0,75, Ω_k = 0 (blue curve) is shown in Fig. 2. In the same figure I show the dependence $H_0a_0r(z)$ for the above model (SEUT), for it the distance between an observer and an object at a redshift z is equal to [1 – 1/(1+z)] = z/(z+1).

3. Luminosity dependence on redshift in different models

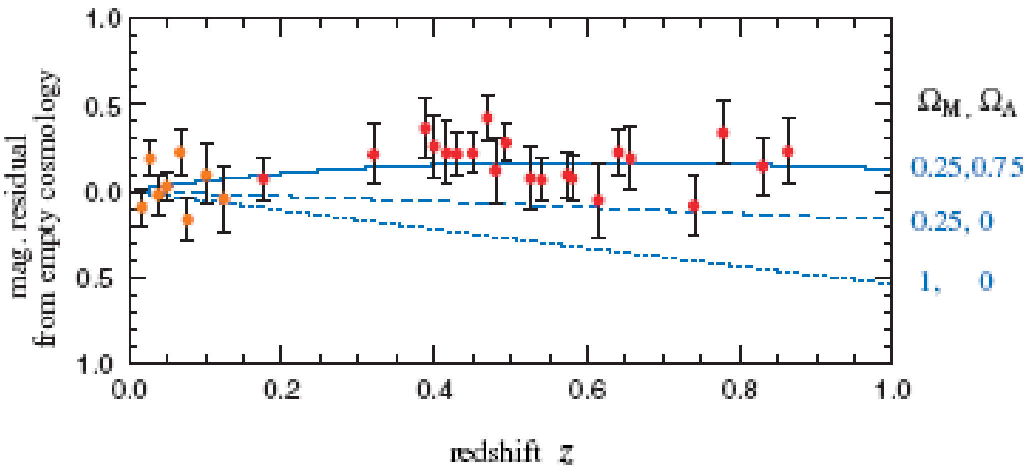

Figure 3. Luminosity dependence on redshift in EF-models for different values of $\mathbf{\Omega_m}$ and $\mathbf{\Omega_\Lambda}$ (at $\mathbf{\Omega_k} = 0$)

The residual luminosity dependence on redshift for EF-models with different values of $\mathbf{\Omega_m}$ and $\mathbf{\Omega_\Lambda}$ (at $\mathbf{\Omega_k} = 0$) is shown on the Figure 2 **[Perlmutter, 1999]**. The magnitude difference Δm at given ***z*** for different models “A” and “B” can be found from the simple expression

$$\Delta m = 5 \cdot \lg \left(r_A(z) / r_B(z) \right)$$

(here 5 is the historically appeared factor, see for example **[Klapdor-Kleingrothaus, Zuber, 1997]**).

Table 1

Z	1,0	1,5	2,0
$r(\Omega_\Lambda = 0{,}75)$	0,55	0,66	0,74
$r_{тшрв}$	0,5	0,6	0,67
$r(\Omega_\Lambda = 0{,}75) / r_{тшрв}$	1,1	1,1	1.1
$\Delta m = 5 \lg [(\Omega_\Lambda = 0{,}75) / r_{тшрв}]$	0,2	0,2	0,2

On can see (in Fig. 2 and Tab. 1) that the difference between SCM and SEUT (at z<2) is not more than 10%. So, the difference between their luminosity magnitudes is not more than 0,2 and is practically equal to the measurement error. Because of that the SCM and SEUT predictions are the same.

4. Conclusion

Thus, the supernovae low brightness problem at high redshift in the standard EF-model is due to the *non-linear* Universe size dependence on its age. One of traditional way to eliminate this dificulty consists in usage of the cosmological constant and in fitting a relation between dimensionless density components ($\mathbf{\Omega_m} = 0{,}25$, $\mathbf{\Omega_\Lambda} = 0{,}75$, $\mathbf{\Omega_k} = 0$).

But the SEUT does not in general provide any cosmological constant usage nor model parameters fitting. However, it can explicate the SN low brightness phenomena. The needed result is only due to the basic postulate of the Universe *linear* expansion. Therefore, contrary to the common opinion, I reject the fact of the Universe accelerated expansion in the modern epoch.

References:

[Benoit-Levy and Chardin, 2009] A. Benoit-Levy and G. Chardin. Do we live in a “Dirac-Milne” Universe? arXiv:0903.2446v1 [astro-ph.CO] 13 Mar 2009.

[Klapdor-Kleingrothaus, Zuber, 1997] H.V.Klapdor-Kleingrothaus, K.Zuber *Teilchenastrophysik*. B.G. Teubner GmbH, Stutgart, 1997

[Palash, 1999] Palash B. Pal. *Determination of cosmological parameters: an introduction for non-specialists.* arXiv:hep-ph/9906447 v1 22 Jun 1999. Available at: http://xxx.lanl.gov/PS_cache/hep-ph/pdf/9906/9906447.pdf

[Perlmutter, 1999] Saul Perlmutter, Lawrence Berkeley Laboratory 50-232,University of California. *High Redshift Supernova Search , Supernova Cosmology Project* Available at: http://panisse.lbl.gov/

[Shulman, 2006] Shulman M.H. *Paradoxes, Logics, and Physical Nature of Time.* Available at: http://www.chronos.msu.ru/REPORTS/shulman_paradoksy.pdf (in Russian)

[Shulman, 2007] Shulman M.H. *Cosmology: a New Approach*. Available at: http://www.timeorigin21.narod.ru/eng_time/Cosmology.pdf

APPENDIX 8. On galaxies angular size evolution

© M.S.Shulman (shulman@dol.ru) and G. Raffel, 2010

(August 2, of 2010. Updated September 10, of 2010)

We analyze a model of galaxy angular size evolution in the Universe depending on redshift. This model is an alternative to the standard cosmological model and allows us to obtain agreement with the observational data if the transverse galaxy size evolves according to the same law as the radial distance from the galaxy.

1. Introduction

As is well known, galaxy angular size dependence on redshift is considered to be an important test for any cosmological model. The author of the recent publication **[Lopez-Corredoira, 2010]** investigates this dependence using large statistics on galaxies with the same luminosities across a wide range of red shifts. The revealed data are compared with the predictions of five different cosmological models. As the author writes, the real galaxy angular size is *inversely proportional* to the redshift (Fig. 1 red curve) which is inconsistent with the prediction of the standard cosmological model (SCM) (the blue curve).

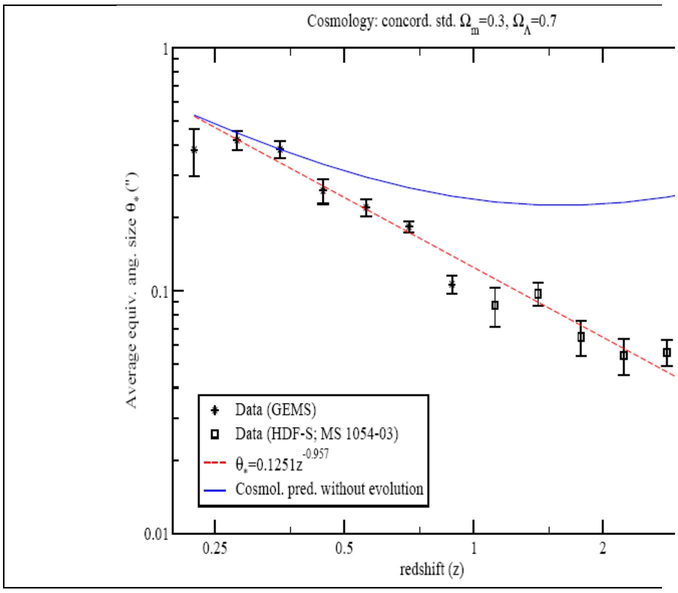

Figure 1 (**[Lopez-Corredoira, 2010]**).

The predicted (SCM) and observed averaged galaxy angular size dependence on redshift.

Below we show that the observed data do correspond to another cosmological model **[Shulman, 2007a]** that has been developed since 1993, called the Spherical Expanding Universe Theory (SEUT).

2. Distances and angles in the cosmology

For the expanding Universe, one can introduce different types of distances. Let us consider a 2D analogue of the Universe, like the surface of a balloon, that is covered by a coordinate grid (e.g. parallels and meridians). During the expansion of this 2D surface, as the distances between coordinate lines increase, the grid itself corresponds to some dimensionless coordinate frame. For example, if the balloon surface contains 10 meridians, then they divide the equator onto 10 similar parts at any radius value. A length measured by these parts is called “the comoving distance coordinate” L_{comov}. On the other hand, any actual length physically expands with the balloon as its radius increases, which determines a metric (physical) distance L_{metr}. These different distances are connected with the scale factor a(t) by the relation:

$$L_{metr} = a(t)\, L_{comov}$$

In our epoch, we set $a(t_0)=1$, and at earlier times t of the Universe evolution $0<a(t)<1$.

In order to take into account an object’s angular size we must consider at least two circumstances. Firstly, we observe the photons emitted from a distant object not as it is now, but as it was at the moment of the photon emission. Secondly, the photon propagation depends on the type of spatial geometry that characterizes the Universe.

Let us consider the second case firstly. In the SEUT, one postulates that the Universe has a spherical type of metric (i.e. a closed geometry model) as depicted in Fig. 2. The circumference in Fig. 2 with radius R and the center at the point O represents a simplified picture of the spherical Universe. An observer is located at the point A, and a galaxy is located at the point D. Here BD=r is the radius of a small circumference. The angle Ω corresponds to the (transverse) galaxy size $d=CE \approx \Omega^*BD=\Omega^*r$, where the interval CE is *perpendicular* to the page plane and to the radial commoving distance AD.

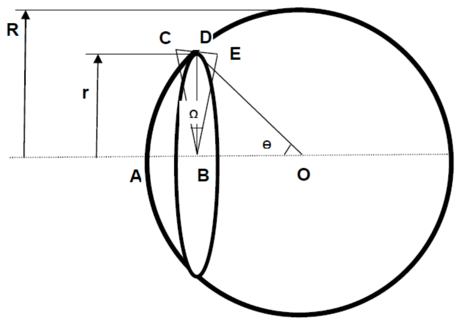

Figure 2. Connection between angles and distances on the spherical surface

Thus, for any surface having this kind of spherical geometry, the relation between the transverse galaxy size d and its angular size for an observer at the point A is

$$d \approx a\, R \sin(r/R)\, \Omega = R \sin(r/R)\, \Omega \,/\, (1+z)$$

In Fig. 1, the angle Θ (for which $\sin \Theta = r/R$) corresponds to the radial commoving distance between a galaxy and an observer. It is important to note that *this angle is also a function of redshift z*.

Now we can complete take into account the first case, namely the evolution of the size of the Universe between the time of the photon emission and its observation. We incorporate the *radial* metric distance expansion by introducing the scale factor a(z) into the *right* part of the above relation. It remains to take into account the dependence Θ(z) to determine an evolution law of the *transverse* galaxy size d on the left side. It is reasonable to consider two possibilities:

- The transverse galaxy size remains constant, and only the radial distance between galaxies increases (i.e., the Universe expansion is specified only for large scales and does not affect the galaxy size evolution).
- The transverse galaxy size increases like the radial distances between galaxies (i.e., the Universe expansion is specified for all scales).

3. SEUT's prediction

First let us note that there is a simple relation between the angle Θ (that corresponds to the radial commoving distance between a galactic and observer) and the redshift z (see **[Shulman and Raffel, 2008]**):

$$\Theta(z) = \ln(1+z)$$

Because of that, we find for the model with *constant* transverse galaxy size:

$$\Omega_{const}(z) \approx d/[a(z)\ R \sin \Theta(z)] = (1+z)\ d\ /\ R \sin[\ln(1+z)]$$

So, we have at small z

$$\Omega_{const}(z) \approx (1+z)*d/[R \sin(z)] \approx (1+z)d/(Rz) = const * (1+z)/z.$$

On the other hand, for the model with transverse size that *evolve*s like the radial distance, the factor a = 1/(z+1) appears before *both* of these quantities, so we have:

$$\Omega_{var}(z) \approx a(z)\ d\ /\ [a(z)\ R \sin \Theta(z)] = d\ /\ R \sin[\ln(1+z)]$$

Then at small z:

$$\Omega_{var}(z) \approx d/[R \sin(z)] \approx d/(Rz) = const\ /\ z.$$

The second case seems to be more natural. In this case, for small z, the SEUT predictions offer qualitative agreement with the observational data from **[Lopez-Corredoira, 2010]**.

Fig.3 shows the results of the precise calculations including approximate dependence Ω(z) ~ 1/z (green curve). The red curve (for the model with constant metric galaxy size) diverges from the green curve already at z ~ 1. On the other hand, the blue curve is nearer to the green one, quantitatively as well as qualitatively. It starts to increase slowly only after z>4.

4. Conclusion

Thus, the SEUT gives a satisfactory description of the galaxy angular size dependence on redshift. Such a conclusion, however, is strongly associated with the hypothesis that the transverse galaxy size expands in the same way as the radial distance.

One can see in the literature two different positions on the transverse size evolution of an astrophysical object. For example, **[Lee, 2009]** argues that the size of galaxies may expand with the Universe if dark matter is in the form of a Bose-Einstein condensate. Also, **[Longair, 2008]** writes in Section 5.4:

> Proper distances perpendicular to the line of sight must also change by a factor *a* between the epochs t and t_0 because of the isotropy and homogeneity of the world model…

However, in Section 7.4.4 Longair assumes galaxies are like rigid rods and gives the formulas for the angular size diameter determination using just such the suggestion.

The authors of the popular science paper **[Lineweaver and Davis, 2005]** consider this question, and argue for constant galaxy size, i.e. when any distance inside a galaxy (or another local object) is changing, then the gravitational equilibrium is disturbed, so a tendency appears to restore the initial distance. This seems reasonable for SCM, because the SCM gravitational force between any two masses m_1 and m_2 is proportional to R^{-2}, where R is the distance between them. However, this is *not true* for the SEUT, because each mass in SEUT is also increasing with time proportionally to R, so ultimately the attraction force $F = Gm_1m_2/R^2$ remains constant, and the gravitational equilibrium *is not disturbed*.

Note, in the point 15.2 of the famous monograph **[Weinberg, 1972]** its author writes that if we accept the “deceleration parameter” and Hubble constant values from the observation data, than we should believe that the Universe density is near $2\rho_{cr}$. But the SEUT leads just to this relation ($\rho = 2\rho_{cr}$) between the actual density and critical one!

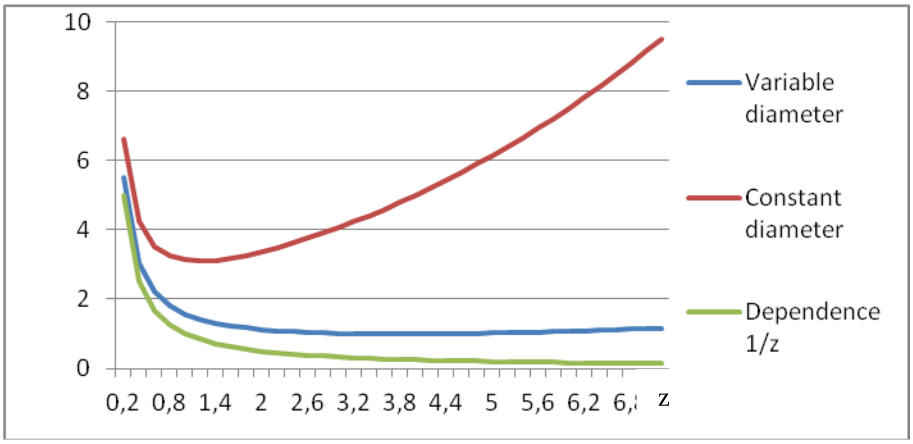

Figure 3
Approximate (green curve) and calculated angular galaxy size dependences on redshift z for the SEUT’s models having constant size (red curve) and variable one (blue curve).

Let us add that the SEUT provides a number of other astrophysical predictions that are confirmed by the observed data as well as, and often better than, predictions of the SCM (**[Shulman, 2007a, 2007b]**, **[Shulman and Raffel, 2008]**, **[Raffel and Shulman, 2010]**).

References:

[Lee, 2009] Jae-Weon Lee. Are galaxies extending? arXiv:0805.2877v4 [astro-ph] 1 Oct 2009.
[Lopez-Corredoira, 2010] Lopez-Corredoira M. Angular size test on the expansion of the Universe. arXiv:1002.0525v1 [astro-ph.CO] 2 Feb 2010.
[Longair, 2008] Malcolm S. Longair. Galaxy Formation. Second Edition. 2008. Springer-Verlag.
[Lineweaver and Davis, 2005] Ch. Lineweaver and T. Davis. The paradoxes of Big Bang. “V mire nauki“, Moscow, 2005 (in Russian).
[Raffel and Shulman, 2010] G.A. Raffel, M.H. Shulman. On the galaxy distribution depending on redshift. 2010. Available at: http://timeorigin21.narod.ru/eng_time/Galaxy_distr_eng.pdf
[Shulman, 2007a] M.H. Shulman. Cosmology: a New Approach. Available at: http://www.timeorigin21.narod.ru/eng_time/Cosmology.pdf
[Shulman, 2007b] M.H. Shulman. On the supernovae low luminosity problem. 2007. Available at: http://www.timeorigin21.narod.ru/eng_time/On_supernovae.pdf
[Shulman and Raffel, 2008] M.H. Shulman, G.A. Raffel. On the Oldest Photons Phenomenon. Available at: http://www.timeorigin21.narod.ru/eng_time/Oldest_photons_eng.pdf
[Weinberg, 1972] Weinberg S., Gravitation and Cosmology: Principles and applications of the General Theory of Relativity, John Wiley and Sons, Inc., 1972.

APPENDIX 9. Time, entropy, and Universe

© Michael H. Sulman, 2009 (shulman@dol.ru)

(Updated: March 01, 2011)

A hypothesis is discussed where our Universe represents some hypermassive black hole in an external World which is inaccessible for any usual observer inside of the cosmic event horizon. Like a working medium of a heat engine, our Universe receives energy from the external heater at relatively high temperature and gives up a part of this energy to the internal black holes in the centers of galaxies (cooler) at relatively low temperature. Since both the black holes and active stars have a *negative* heat capacity, a difference of the temperatures (as well as deviation from the equilibrium state) in the galaxies increases (not decreases) during billions years.

1. Introduction

The thermodynamic processes are crucial in the life evolution on Earth as well as in Universe. We observe the evolution that is very distant from the thermal equilibrium rise.

In his famous work **[Schrödinger, 1955]** E. Schrödinger writes that metabolism or energy exchange in a living organism is not important as such, since any atom or calorie have the same value as another one. Further, he says that this organism increases continuously its own entropy, so it produces *positive* entropy and approaches to the dangerous state having maximal entropy that leads to the death. The organism may keep off by continuous extracting only some *negative* entropy from environment, by executing a work, and by dissipating a heat[19]. The negative entropy is what that the organism eats up.

When we consider the cosmic scales, the Second Law application to the whole World as closed system leads to the striking contradiction between the theory and the experience. Universe is not in the state of complete physical equilibrium, its real features have not any common with a feature of an equilibrium system. One notes also that the present state of Universe had to appear from a state with a lower entropy, etc. Hence, its initial state had the lowest entropy, i.e., a very small probability of realization that has not any explication until now, as the authors of the famous textbook **[Landau and Lifshitz, 1976]** write.

The goal of this publication is to propose a model of Universe that allows us to reconcile the observing evolution with the thermodynamics laws. This model is close to a some kind of heat engine concept in which a working medium receives energy from a heater at relatively high temperature and gives up a part of this energy to a cooler at relatively low temperature. So, this working medium represents an *open* system where the *output* entropy flow is *more* than the *input* one. Thus, the entropy *decreasing* and progressive evolution are possible. This process of the part energy using to transform it into work turns out to be stationary, it becomes possible due to the cooler presence only.

2. Universe as open system

Such the model works at the level of the system “Sun-Earth-Space”. In fact, the photons leave the solar surface at the temperature near to 6000 K, and then (after a range of transformations) are reemitted to the cosmic space having the temperature near to 3 K (present epoch). Differently from a typical heat engine, in this case a conditional

[19] We also may imagine a robot, which extracts an energy using a solar battery or external accumulator cell. In the last case our robot can use the received energy (may be, partially) to search for a new energy source and by this way to support its “vital activity”.

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thermodynamic cycle finishes every time in another point having the lower temperature that in initial one. Note, the solar photons energy is distributed between living organisms, climatic disturbances, and energy recourses creation (oil, gas, coal, uranium-ore deposits, etc.).

Our basic goal is to show that the heat engine model is applicable to whole Universe too. At first sight this problem seems to be insoluble, since it is very difficult imagine what could be a heater and what could be a cooler. In order to answer these questions, we have to do two radical assumptions that I going to develop and motivate.

The first assumption consists in that our Universe *is not a closed system*. Contrary, it represents a hypermassive increasing black hole (BH)[20] inside of some "maternal" World, which is in principle inaccessible for any usual observer inside of the cosmic event horizon. As it is well known, the mass increasing of a electrically neutral non-rotating BH is proportional to its size rise. If for such BH we will introduce a "parametric" time[21] using its radius dividing by the velocity of light, then we may **[Shulman, 2009]** find out for it a solution of the Einstein-Friedmann's equation that corresponds to the originally assumed mass increasing, and this "parametric" time is in principle the same as outside from BH as well as inside of it. The considered BH turns out just to be *expanding* Universe, and its expansion is exclusively due to a matter coming outside from it.

The absorption of the external matter and energy is connected with the increasing of the "external" BH's entropy (i.e., of its event horizon surface). So, the "maternal" World can play the role of *heater* for our Universe.

The second assumption is connected with the searching for a *cooler*. Here, it is useful to remember that the supermassive BHs having a mass near 10^6 solar mass are usually disposed at the center of galaxies. As it is known **[Bekenstein, 2003]**, one can evaluate the BH's event horizon temperature using the relationship $T_{BH} \sim 10^{26}/M$, where M is the mass (expressed in grams), temperature T is expressed in Kelvins. As the solar mass is near to 10^{33} g, then the supermassive BH temperature is very close to the absolute zero and supports very high efficiency of such cooler for its galaxy.

Recently, the very interesting paper **[Egan and Lineweaver, 2009]** appeared that contains a detailed budget of different components Universe's entropy. The "external" entropy (i.e., entropy of the cosmic event horizon) is near to 10^{123} *k* (where *k* is the Bolzmann constant), while the "internal" entropy does not exceed $10^{103}k$. The main contribution into internal entropy is due just to the largest supermassive BHs at the center of galaxies, while the solar mass BHs have total entropy near $10^{95}k$, photons and relic neutrinos near $10^{88}k$, etc.

The difference between the "external" and "internal" entropy is nearly 20 orders. It is interesting that the difference between the Sun's entropy and the BH's entropy having the same mass is also the 20 orders **[Bekenstein, 2003]**. With such difference of the values one can assume that the tendencies of these two types of entropy may sometime be opposite, i.e. an increasing of the total entropy of the cosmic event horizon and internal BHs the entropy of the remaining Universe part can decrease. Note, the stars formation and nuclear energy accumulation in them is very similar to the accumulation processes of the organic and mineral resources on our planet.

Finally, both the BHs and active stars are strongly gravitating systems and have the *negative* heat capacity. In other words, the stars *emit* their energy and *warm*, while the BHs absorb the energy and their temperature *decreases*. Thus, a difference of the temperatures (as well as deviation from the equilibrium state) in the galaxies increases (not decreases) during billions years.

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[20] If the hypothesis is correct, then the Big Bang should be identified with the gravitational collapse that led to the our Universe birth. Some analysis of the event dynamics could allow us to precise details of the first time moments of its evolution.

[21] The concept of parametric Time as measure of an arbitrary object variability was formulated in the works of prof. A. Levich (See, for example, **[Levich, 1988, 1995]**).

References:

[Egan and Lineweaver, 2009] Ch. Egan and Ch. Lineweaver. A larger estimate of the entropy of the universe, arXiv:0909.3983v1 [astro-ph.CO] 22 Sep 2009

[Landau and Lifshitz, 1976] Landau L.D. and Lifshitz E.M., Statistical physics, part 1. Moscow, Nauka,1976 (in Russian).

[Levich, 1988] Levich A.P. Metabolic time of natural systems // System Studies. Annual edition. 1988. Moscow: Nauka. 1989. Pp.304-325 (in Russian). Pp.117-126 (in Russian).

[Levich, 1995] Levich A.P. Time as Variability of Natural Systems: Ways of Quantitative Description of Changes and Creation of Changes by Substantial Flows // On the Way to Understanding the Time Phenomenon: the Constructions of Time in Natural Science. Part 1. Interdisciplinary Time Studies. Moscow: Singapore, New Jersey, London, Hong Kong: World Scientific. 1995b. Pp.149-192. Available at:
http://www.chronos.msu.ru/EREPORTS/levich1.pdf

[Schrödinger, 1955] Schrödinger E. What is Life? The Physical Aspect of the Living Cell. 1955.

[Shulman, 2009] Shulman M.H. Time and Black Holes. Available at
(http://timeorigin21.narod.ru/eng_time/Time_and_BH_eng.pdf)

APPENDIX 10.

"Extremely Large" Dirac Numbers and Fundamental Constants in Cosmology

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(October 27, 2013. Updated: November 8, 2013)

The Dirac's approach to interpret several dimensionless physical constant combinations is revisited. Particularly, I argue that ratio of the current Universe mass to its size is constant, and the ratio of this mass to the Planck mass (as well as the ratio of the current Universe size to the Planck length) is typical "extremely large" Dirac number that specifies the dimensionless Universe age. I suppose the new viewpoint on the Planck action constant.

The Dirac's conjecture

The great British physicist Paul Dirac in his lecture presented at the School of Physics, University of New South Wales Kensington, Sydney, Australia in August of 1975 **[Dirac, 1978]** pointed out to the interesting coincidence between the value orders of several dimensionless combinations of physical quantities. For instance, the ratio of the electrostatic force to the gravitational one is

$$\frac{e^2}{Gm_e m_{prot}} \approx 2\cdot 10^{39}$$

where e is the charge of the electron (and proton), G is the gravitational constant, and m_e, m_{prot} are the mass of the electron and the proton, c is the velocity of light. On the other hand, the ratio of the current Universe age τ_U to the time required for light to traverse a classical electron $\tau_e \approx e^2/m_e c^3$ is:

$$\frac{\tau_U}{\tau_e} \approx 7\cdot 10^{39}$$

Dirac supposed that "there must be some fundamental reason in Nature why these two large numbers should be so close together", that both of them should increase with time, as well as the gravitational constant and Universe mass also should evolve with time. This conjecture didn't lead to a successful prediction, it was considered by many physicists as some kind of numerology. The problem itself remains to be interesting for the researchers; however, it was not commonly resolved.

Even the genius failure shouldn't be ignored because the treasure that he didn't find may be concealed very closely! This publication represents an approach to find some rational (and close) explanation of the above facts in the framework of the cosmological model that differs from the Standard Cosmological Model (ΛCDM). I develop that nonstandard model (the Spherical Expanding Universe Theory – SEUT) since 1993 (see, e.g., **[Shulman, 2011]**). The SEUT postulates that our Universe is the *black hole in an external 4D super-Universe*. It is the reason of the Universe irreversible expansion due to the matter and energy absorption. Correspondingly, in our model (contrary to the Standard Model), the Universe size evolution is accompanied by its mass increase, and the conservation law also cannot be fulfilled (however, this effect is *relatively* very small: ~10^{-10} per year in the current epoch) because the Universe is the open system [22].

Planck units

In 1899 Max Planck proposed the system of the “measurement natural units”. It bases now particularly (but not exclusively) on the velocity of light c, the gravitational constant G and the Planck constant $\hbar$.

In this system one may determine the Planck units of mass, length, and density using the expressions

$$m_p = \sqrt{\frac{\hbar c}{G}} \approx 2.1 \cdot 10^{-5} g\,, \qquad l_p = \sqrt{\frac{\hbar G}{c^3}} \approx 1.6 \cdot 10^{-33} sm\,, \qquad \rho_p = \frac{m_p}{l_p^3} \approx 10^{94} g/sm^3$$

Note that the ratio of two first above quantities is equal to

$$\frac{m_p}{l_p} = \sqrt{\frac{(\hbar c/G)}{(\hbar G/c^3)}} = \frac{c^2}{G} \approx 10^{28} g/sm$$

One also may introduce the Planck temperature (k_B is the Boltzmann constant):

$$T_p = \frac{m_p c^2}{k_B} = \sqrt{\frac{\hbar c^5}{G(k_B)^2}} \approx 10^{32} K$$

Physical meaning of the gravitational constant

Any dimensional physical constant is connected with physical meaning of the measured quantities where it is used as well as with an arbitrary choice of the unit system. The gravitational constant G analysis one usually associates with the Newton gravity law:

$$F = GM_1M_2/r^2$$

However, as I believe, it is better to use another known relationship:

$$R = 2GM/c^2$$

where R is the gravitational radius of a body having mass M, c is the velocity of light. The simple linear connection between distance and corresponding mass follows from this relationship, so we may consider them as the same physical quantity.

Moreover, from the point of view of an external observer the above relationship is “the basic equation of state of the black hole”, because its size increases with mass, and their ratio has to be constant. Let us denote the Universe current radius as R_U and its current mass as M_U. If the main postulate of the SEUT is true and our Universe is really the black hole, then the ratio of its mass to the radius at any epoch (including modern one) is equal to the constant quantity

[22] A.D. Linde in his lecture in Physical Institute Of the Russian Academy of Sciences (2005) talked that the initial mass of the Universe was extremely small – less than one milligram. However, the SEUT and the modern inflationary cosmology not only drastically differ one from another but even compete in order to explain several difficulties of the Standard Model. I thank Yu. A. Lebedev who said me about this fact.

$$\frac{M_U}{R_U} = \frac{c^2}{2G}$$

As it is well known, $M_U \approx 10^{56} g$, $R_U \approx 10^{28} sm$, so their ratio has the order near 10^{28} *g*/*sm*.

“Extremely large” Dirac number

Thus, if we ignore the unimportant factor 2 (one may exclude it by the redefining m_p or l_p), then we get

$$\frac{M_U}{R_U} = \frac{m_p}{l_p} = \frac{c^2}{G}$$

This fact confirms the main conjecture of the SEUT that the Universe mass/size ratio is unchanged at any epoch.

Furthermore, we now can easily deduce and check **[Wikipedia]** that

$$\frac{M_U}{m_p} = \frac{R_U}{l_p} \approx 10^{60} \equiv D$$

The introduced number D shows how much the current Universe mass and size are increased during the Universe evolution time and determines the dimensionless Universe age. I propose name it “the Dirac number”.

It is naturally to believe that Planck time is the time point of the Big Bang, i.e. the time point of our Universe ancestor gravitational collapse. Then we come to the following remarkable issues:

- The initial size of our Universe was $l_p \approx 10^{-33} sm$.
- The initial mass of our Universe[23] was $m_p \approx 10^{-5} g$.

Before all, one should point out that the characteristic modern and Planck durations can be found using simple division of the corresponding spatial sizes by the velocity of light, so the ratio of these durations is trivially equal to the ratio of these sizes.

Let us note that in the Standard Cosmological Model there is so-called cosmological constant Λ that was introduced into Einstein equations as “free parameter”; although that constant seems to solve some problem, however, instead of that it creates other problems that are more difficult than previous one. In the SEUT one has not to introduce this constant because in it the solution automatically appears where the matter (negative) pressure[24] is inversely proportional to the Universe current size. Finally, the *fictive* cosmological constant that physically corresponds to this current density turns out to be equal

[23] One can sometimes meat in a literature the incorrect (in my opinion) statement that Planck mass is “the maximal possible mass of an elementary particle”.

[24] One usually supposes (following Einstein) in the Standard Model that the matter pressure in the Universe is zero.

$$\Lambda \approx \frac{1}{R_U^2} = \frac{1}{D^2 l_p^2} \approx 10^{-122} \frac{1}{l_p^2}$$

Physical meaning of the "Planck constant"

Thus, the ratio $\frac{M_U}{R_U} = \frac{m_p}{l_p}$ turns out to be not depending on the Planck constant $\hbar$. However, the relation between m_p and M_U, and also between l_p and R_U , depends on it. Probably, the parameter $\hbar$ somehow specifies the current epoch of the Universe expansion and can have another value at other epoch (cf. the above conjecture of Dirac!).

Earlier I showed **[Shulman, 2004]** that the basic novelty of Heisenberg when he created the Quantum Mechanics consisted in the introduction of the *complex* numbers to describe (particularly) the electron spatial orbits in atoms. The *new commutation rules* for such observables as position and momentum (or time and energy) was the straight consequence of this introduction; in the classic physics these rules were the trivial ones for usual c-numbers. In particular, when one describes classical oscillators using the *complex* numbers (which do not equal to their complex conjugates) the analogs of the quantum-mechanical commutators appear. Of course, the quantity $\hbar$ is not used there, but the expressions[25] like Ψ, Ψ^*, $|\Psi| = \Psi^*\Psi$, etc. do appear. Each such the oscillator without loss (phase shift between position q and momentum p is $\pi/2$) can be described using a commutator in a form

$$[q, p] = q^* p - qp^* = iq_{\max} p_{\max} \quad ,$$

where the maximal (real) values of q and p are on the right hand.

The genial achievement of Dirac that led to the transition to the matematics of Quantum Mechanics finally consisted in the replacement of the individual products $q_{\max} p_{\max}$ for each concrete classical oscillator by the *universal* dimensional constant of action[26].

Note that when we talk on an oscillator we in fact take into account the wave origin of matter as de Broglie declared. Also we have to account that the wave which corresponds to quantum particles ("de Broglie - Bohm Pilot Wave") is *non-local* and *propagates* in space with infinite velocity. These waves cannot transfer physical information, but they can lead to a non-local correlation between spatial points that are separated by a timelike distance (like EPR experiments).

As it is well known, the parameter $\hbar$ appears in the quantum relations where one operates by *energy* and *momentum*. In the framework of the physics geometrization I would like to precise what physical meaning these quantities have. The SEUT proposes the simple and clear statement that completely corresponds to the Quantum Theory:

> *Energy and momentum are the quantum numbers that express the ratio of the Universe age (radius) to de Broglie wave period (wave length) of the concrete particle*.

So, the wave nature of every particle makes it a specific "clock" and "ruler" that measure the Universe evolution. Let us remember that in the SEUT (contrary to the Standard Model) de Broglie period and length are considered as unchanged over the Universe expansion.

As it is shown, the Schrödinger equation historically was deduced by its author via the generalization of the expression for the de Broglie wave length. Let us make an inverse way -

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[25] The simplest well known example of such the conception use is the power calculation in the alternative current circuits.

[26] Dirac he-self originated from the Poisson bracket that is very closed to such the complex commutator for a classical oscillator.

from the particle potential well to the free one (according with the Seut we consider the Universe size as *finite*).

Let us now mentally increase the well width (in which some quantum particle is disposed) until one border of the well will coincide to the other one (remember, the Universe is considered as finite and closed). Now we don’t need in the infinitely high walls of the well as the condition to quantize, and the length’s number has to be integer again. Meanwhile, the wave length expresses now via the Universe perimeter, not via an arbitrary well size.

As we didn’t change something in the formal problem definition, the product wave length and momentum is stll equal to the Planck constant. It is very important and nontrivial (but predictable) that appearing discretness occurs to be the simple consequence of the Bohr quantization rule. So, the fundamental link between momentum and wave length turns out to be the same for photons and other particles having a non-zero mass:

$$p = 2\pi\hbar/\lambda \ , \quad E = 2\pi\hbar/T$$

Here p is a particle momentum, E is a particle energy, λ and T are particle de Broglie wave length and wave period. Accorging with the SEUT (and contrary to the Standard Cosmological Model) λ and T remain unchanged, and momentum p and energy E increase linearly with time. Thus, such the linear rise is due to the quantity $\hbar$ that has now to be proportional to the size (age) of the Universe and should not be called the “Planck constant”:

$$\hbar(t) = \Pi \cdot R$$

(To retrieve this we will denote the new constant by the Greek letter “Π” in honor of Planck). So, the new constant may be found from the relationship

$$\Pi = \frac{\hbar_U}{R_U} \approx \frac{10^{-27} erg \cdot s}{10^{28} sm} = 10^{-55} g/s$$

All the quantum processes should be considered in the framework of the SEUT as *non-local* oscillations of whole Universe (like shell oscillations of the hypersphere).

When the Universe size will, e.g., twice, then Planck value will multiply by 2 too. On the other hand, when the Universe size was equal to $l_p \approx 1.6 \cdot 10^{-33} sm$, the Planck parameter was $\hbar_p = \Pi \cdot l_p = 10^{-55} \cdot 1.6 \cdot 10^{-33} \approx 10^{-88} g/s$, so $\hbar_U/\hbar_p \approx 10^{60} = D$. I don’t see any decisive objections against these drastical conclusions.

The proposed viewpoint allows us to estimate the particle minimal mass value at the current epoch. According to de Broglie rule it has to correspond to the maximal size (the Universe size) R_U:

$$m_{\min} c \approx \frac{2\pi\hbar}{R_U}$$

The found minimal mass value is very small, ~ 10^{-66} *g*, while the electron mass is near 10^{-27} *g*. Note, the close value $m_{\min}$ was found in **[Wesson, 2003]** using a dimensionality consideration.

Electrical charges

It is interesting to compare the Planck mass with the Planck charge:

$$m_p = \sqrt{\hbar c \cdot \frac{1}{G}} \quad \text{and} \quad q_p = \sqrt{\hbar c \cdot 2\varepsilon_0}\ .$$

Here ε_0 is the permittivity of free space. Such the comparison leads to the conclusion that the ratio $q_p / m_p = \sqrt{2\varepsilon_0 G}$ doesn’t depend on time. Because of that it is possible that electric charges (e.g., electron charge) increase proportionally to the Universe age, not only masses. If so, then the fine structure constant $\alpha = (e / q_p)^2$ increases proportionally to the Universe age too.

References

[Dirac,1978] P.A.M. Dirac. Directions in Physics. John Wiley & Sons. NY, 1978.
[Shulman, 2004] M.H. Shulman. Variations on Quantum Theory, 2004.
http://www.timeorigin21.narod.ru//eng_quantum/Eng_variations.pdf
[Shulman, 2011] Time origin and Universe uniform expanding.
http://www.timeorigin21.narod.ru//eng_time/Universe_expansion_eng.pdf
[Wesson, 2003] Wesson, P.S., Mod. Phys. Lett. A**19** (2004) 19952000, gr-qc/0309100).
[Wikipedia] Planck units. http://en.wikipedia.org/wiki/Planck_units

APPENDIX 11.

A blunder anatomy or the modern cosmology's "winding and rugged road"

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Amicus Plato, sed magis arnica veritas

There exists a contradictory understanding of so called cosmological constant Λ. One links it with a *repulsion* force, while Einstein himself clearly pointed out that this constant has to correspond to the *attraction* force which could in his opinion equilibrate the repulsion between the same electric charges. Such the representation is very popular in the scientific literature. However, I propose an alternative viewpoint that explains the physical meaning of the matter negative pressure.

Einstein's static Universe model and modern cosmology's statement

At the 20^{th} century beginning Albert Einstein proposed the cosmological model like the closed on itself 3D hyperspherical shell. The initial Einstein's model was *static*, i.e., the shell radius R was supposed to be constant and not depending on time. It follows from Einstein's cosmological equations:

$$d^2R/dt^2 = - (4\pi GR/3)(\rho + 3P/c^2), \quad (1)$$

where ρ is mean matter density, P is the matter pressure, G is the Newtonian gravitational constant, c is velocity of light. If the shell radius does not change[27], then the left side is equal to zero, hence, right side has to be equal to zero too. If density ρ is positive, then the pressure P has to be negative.

Einstein believed such the decision to be incorrect. In the chapter IV of his book **[Einstein, 1953]** he wrote that *there is no any physical reasons* to introduce the negative pressure. Instead of that he introduced a (formally accessible) *additional term*[28], so the equation (1) became

$$d^2R/dt^2 = - (4\pi GR/3)(\rho + 3P/c^2) + R\Lambda c^2/3, \quad (2)$$

where Λ is so called cosmological constant. Einstein also proposed to neglect the matter pressure P, i.e., to set is to zero.

It is clearly, such the quantity Λ should really be linked in any case with some physical phenomenon that creates a negative pressure. Einstein completely understood that this mysterious negative pressure had to generate the *attraction*. He wrote in the above book (Addition 1) that one had include an additional members into Maxwell's theory in order to obtain the charged particles stability regardless the mutual repulsion of their similar charges. Poincaret supposed that inside of these particles there exists a negative pressure which compensates such the electric repulsion. Einstein suggested that such the attractive forces exist outside from the particles too.

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[27] Or changes linearly.

[28] One often wrongly states that the original Einstein's solution without this additional term *exists, but is not stable*. However, Einstein himself pointed out **[Einstein, 1933]** that an instability is just specified for the solution with such the term. Hi referred to Lemaitre and Friedmann; see also the detailed analyzis in **[Eddington, 1930].**

So, Einstein here says *clearly* that an *effective* pressure corresponding with the constant Λ should be *negative* in order to compensate some repulsion and to provide an *attraction*.

In practice, all the modern cosmologists ascribe to Einstein the exactly *opposite* statement that parameter Λ is connected with a *repulsive* force which he introduced in his theory in 1917 in order to compensate the gravity force.

Particularly, one of the authors writes: since the force action is universal like gravity, we can call them the 'vacuum gravity', though usually gravity is associated with an attraction, not with repulsion.

Another author even cites Einstein's words about his "winding and rugged road" to such the idea. However, in the source book **[Einstein, 1917]** Einstein talks (see §2) about absolutely another (genial) idea when one replaces a flat world and its boundary conditions by a world closed on itself where a boundary condition is avoided. What about the cosmological constant, Einstein talks about it only in §4, and there is no any word about repulsion forces in this paper.

The proposed paradox solution

So, we have the explicit *contradiction*. On the one hand, there is a *negative* pressure in the Einstein's equation (1) that denotes the negative energy volumetric density and that Einstein himself associated with a *contraction*. On the other hand, *if one considers the equation (2) as a motion equation*, then the member having the positive Λ (as well as a negative pressure P) should really lead just to the repulsion *phenomenon*. It seems to be paradoxical, although generally a negative energy density of a body generates a contraction only if an environment's density is more than body's one (but it may be negative too).

But could we consider the equation (1) as a motion equation? In my opinion, the paradox origin is connected just with the incorrect interpretation of this equation. This interpretation treats the cosmological evolution as a *process of obtaining* some balance between contraction energy and repulsion one. At this one associates the contraction with the matter density ρ and believes that the repulsion corresponds to the pressure P or cosmological constant Λ. In other words, in the non-stationary model the kinetic energy of Big Bang competes with the gravity potential energy, and they obtain an equilibrium in the source steady-state Einstein's model[29]. Note, that in the non-relativistic version of the equation (1) that was proposed by E. Milne there is in brackets single density matter ρ only, not $(\rho+3P/c^2)$. This is a reason for many authors to say something like "pressure has a weight in General Relativity!" that should mean that the transition from Newton's physics to Einstein's one we have to replace the matter density by the sum "density plus three times pressure"[30].

I believe, all is not so: there is no some *internal* cause determining evolution or statc state of the Universe. In fact, the Milne's hypothesis who considered the Newtonian universe as Euclidean and infinite is *contradictory* as such. Let us consider a virtual sphere in such the universe where radius is R, matter density is ρ. When the radius R increases, its mass M increases as R^3, hence its gravitational radius R_G increases as R^3 too. Because of that after some R we will have $R_G>R$ and all this sphere mass will collapse. Thus, our Universe *cannot not be a black hole* in some external world containing a matter (see more details in **[Shulman, 2011b]**).

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[29] Such the approach was formulated by E. Milne in the work **[Milne, 1934]** and the following paper **[McCrea and Milne, 1934]**.

[30] Such the sentences one usually are added by the reference to the monograph **[Tolman, 1934]** without any precision. I studied this monograph and found out that the statement may be related with §65 where the author says on *electromagnetic radiation energy density* exclusively (it is equal to aT^4 while the pressure is $aT^4/3$, *a* is constant).

But it is well known that a black hole rises irreversibly absorbing a matter and energy from outside. Namely this *external* cause determines the evolution of our Universe. Hence, such the evolution does not depend at all on its *internal* state. Contrary, just the actual values of its mass and radius determine unambiguously the average matter density ρ and pressure P in it[31]. It turns out that the pressure is in fact *negative* and corresponds with the negative energy volumetric density (see, e.g., **[Shulman, 2011a]**). And practically we can observe the absolutely real phenomenon – the universal matter (gravitational) attraction.

The paradox absence in such the model may be explained by that the equation (1) *is not* "a motion equation", since the motion (and the gravity phenomenon) is determined *inside of* hyperspherical shell, and the Universe expansion (its curvature radius evolution) happens normally to this shell, i.e., outside its 3D space. "The center" of 3D shell cannot to be a gravitation source relative to material bodies of the shell. So, I think that the Milne's analogy between a particle cloud explosion and the Universe expansion has not any physical meaning.

Thus, the gravity law that Newton introduced to the classical physics "by hand" appears as a *natural* consequence of the proposed model. It is very important that we do not need in the cosmological constant use. Note, Newton introduced the gravity law as an *addition* to its second law that connects inertial mass with acceleration. When one considers some "usual body" he ignores "the gravity pressure" P_g because it is very small; however, such the pressure tends to contract even a smallest drop of matter. Meanwhile, one cannot ignore this phenomenon for large astrophysical objects, and physicists use the special term "self-gravitation" for them. In the equation (1) one should understand the quantity P as sum of P_g and all the remaining sorts of the pressure (for example, the dynamical pressure of moving particles); namely P_g predominates in the cosmological domain.

Of course, the rejection of the Standard Cosmological model unambiguously leads to the necessity to show that a new cosmological model is possible and able explain all the real cosmological observations. The results of my own investigations since 1993 hardly assure me that this problem is effectively solved (see my articles on the web-page at http://timeorigin21.narod.ru/eng_time/eng_time.html).

References

[Eddington, 1930] Eddington A.S. On the Instability of Einstein's Spherical World. MINRAS, May 1930, p. 668-688. Royal Astronomical Society (Provided by the NASA Astrophysics Data System).

[Einstein, 1917] Einstein A. Kosmologishe Betrachtungen zur algemeinen Relativitätsthtorie. Sitzungsber. Preuss. Akad. Wiss,. 1917, **1**, 142-152.

[Einstein, 1933] Einstein A. Sur la Structure cosmologique de l'Espace. Hermann et Gie Editeurs, 1933, p. 99—109.

[Einstein, 1953] Einstein A. The Meaning of Relativity, Princeton, 1953.

[McCrea and Milne, 1934] W. H. McCrea and E. A. Milne. Newtonian universes and the curvature of space. Q. J. Math. Oxford **5**, 73–80 (1934), reprinted in Gen. Relativ. Gravit. **32** (9), 1949–1958 (2000).

[Milne, 1934] E. A. Milne. A Newtonian expanding universe. Q. J. Math. Oxford **5**, 64–72 (1934), reprinted in Gen. Relativ. Gravit. **32** (9), 1939–1948 (2000).

[Shulman, 2011a] Shulman M. Time origin and Universe uniform expansion. See http://timeorigin21.narod.ru/eng_time/Universe_expansion_eng.pdf

[31] I.e., a fixed balance between the "kinetic" energy and "potential" (gravitational) one of any particle in the reference frame of an arbitrary observer. Note, the more curvature radius of the Universe, the less modulo of the average matter density and the pressure.

[Shulman, 2011b] Shulman M. Can the Universe not be a black hole? See http://www.timeorigin21.narod.ru/eng_time/Universe_must_be_bh_eng.pdf
[Tolman, 1934] Richard C. Tolman. Relativity, Thermpdynamics And Cosmology. Oxford, Clarendon Press, 1969.

APPENDIX 12. Unfinished suite for Universe … (history of a way in cosmology)

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(March 17, 2015)

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1 Introduction

In 1993 I had read just published the collection of selected papers of the remarkable Russian astrophysicist Nikolay A. Kozyrev whose ideas I met before in the popular magazines only. His "causal mechanics" does not impress me, but two important ideas turned out very interesting.

The first one consisted in the prediction that "time transforms to energy". Of course, from the standard viewpoint such the statement seems to be a heresy. However, several heresies may be crazy enough to be transformed into the truth.

The second idea introduced into science a new conception – the time "course". Before that I did not reflect about the time nature and especially about the time course. Earlier I believed that the time notion was beyond physics. However, after reading the Kozyrev's work I understood that we had to include this notion into our cosmological model. Also I understood that we have to *relate the time course with the Universe global expansion process* (all other process are secondary ones). In other words, time turned out to be similar to annual rings that appear during a tree evolution.

After I postulated the a-priori (i.e., by definition) proportionality between the (non-empty) Universe age and its size, I met at least two fundamental contradictions. Firstly, such the proportionality does not correspond to the standard condition of energy conservation. Secondly, in the new Universe model its mass increases linearly with time (contrary to the standard model). The both contradictions can be eliminated using the single assumption: our Universe is a "black hole" that absorbs energy/matter from some external hyper-world.

Initially I was afraid to pronounce such the idea. However, later it turned out that the idea "was in the air" at least since 1972.

2 Who was the first …

Just in 1972 two very different oracular papers were published synchronously and independently. The Indian physicist-theorist R. K. Pathria wrote the article [1] "*The Universe as a Black Hole",* and the British mathematician I. J. Good wrote his article [2] named: *"Chinese Universes".*

The Pathria's article is written as a strongly scientific one; I am in full agreement with his words. At the beginning of this work he writes:

> *"… the universe may not only be a closed structure (as perceived by its inhabitants at the present epoch), but may also be a black hole, confined to a localized region of space which cannot expand without limit… for the universe as a whole, its Schwarzshild radius would woulb of the order of 10^{28} cm. Because the linear dimensions associated with the universe are also of the order of 10^{28} cm, the question arises: Is the universe itself a black hole? To investigate this question, the customary view of the universe, which is necessarily internal, is not sufficient; it has to be supplemented with an external view – I assume that there exists, outside our universe, an external world from which one may take a 'detached' look at our universe. "*

He formulates the “internal” view using the Einstein’s Equation and deducing from it the specific inequalities for the Universe radius. Then he very elegantly describes our Universe “from outside” considering it as a black hole satisfying to the Schwarzshild’s metrics. He deduced the similar inequalities in this case too. Finally he uses the Hubble constant value $H_0 \approx 75$ km s^{-1} Mpc^{-1} and deceleration parameter $q_0=1$ in oreder to estimate the our Universe radius as 1.1 x 1028 cm. In conclusion he writes:

“… we are now faced with several questions: How did the universe come to be a black hole – through a gravitational collapse, followed by a phase of expansion? In the cosmos, which includes the exterior as well as the interior of the universe, can our universe be unique? If not, what would its status be vis-à-vis other such structure in the cosmos? Investigation of these and other related questions, including the possible existence of any hierarchy of black holes, is clearly a matter of some importance.”

The Good’s article is written in the very different (not scientific) style, without any formula. Good remembers the Greek with whom he is fully concordant:

“From the unreasonable assumption that change is impossible, Parmenides inferred about 500 BC that the universe had no beginning, in itself a reasonable belief. In fact the notion that that the universe came into existence either with a big bang or with a whimper might one day seem as absurd as that the earth rests on an elephant that stands on a tortoise. Any evidence that the universe had a beginning can be more reasonably interpreted by saying that some cataclysmic event occurred, perhaps some ten billion years ago, which completely transformed the observable universe. … I shall argue here that the whole of our observable universe is probably a black hole. ”

At the end of his “poetic” work Good came to the following conclusion:

“… we are inside an infinite sequence of holes, one within the other, like carved Chinese spheres, consisting alternately of ivory and ebony … the present theory interprets collapsed galaxies … as subuniverses, and it is intended to resolve the conflict between the big-bang and steady-state theories of the origin of the universe. Although the theory seems grandiose, as far as I can see it is the only possible consistent interpretation of the steady-state concept ”.

Later the American physicist-theorist Lee Smolin wrote in [3] after referring to the famous scientist Jh. A. Weeler:

“It may … be conjectured that each black hole of our universe leads to such a creation of a new universe and that, correspondingly, the big bang in our past is the result of the formation of a black hole in another universe.”

In the 21-st century this grandiose idea sometimes attracted the attention of physicists. For example, a number of papers was published [4] by American physicist N. J. Poplawski. Even the stable orbits existence inside of black holes was discussed [5]. However, I believe that such the works are beyond of the main way to whom my publication is devoted.

The main question, in my opinion, is: could our Universe *not be a black hole?* The answer is clear for me [6]. In fact, we know the averaged density of the Universe ($\sim 10^{-29}$ g/cm^3). But the Universe having a finite averaged density cannot have an infinite size! Really, the geometrical Universe radius is proportional to the cube root from the mass, while the gravitational Universe radius is proportional to the mass itself, these dependences will necessarily cross at some critical radius value (it just is equal $\sim 10^{28}$ cm) that limits the

Universe size. Furthermore, when we estimate a ratio real/critical mass for such the objects as Earth, Sun, Milky Way, and the Universe as whole, we see clearly that such the ratio changes from 10^{-26} up to ~ 1.

3 Is there something "inside" of a black hole?

The common accepted paradigm of black hole consists in two parts: the external one and the internal one.

For an external observer in our 3D space black hole is exactly described by the "membrane approach" that was proposed in 70s of last century. With this approach the BH event horizon is seen as *2D physical membrane of a viscous liquid having several mechanical, electrical and thermodynamic features* [7].

But what about of the BH interior? To present day the astrophysicists accept the very power and elegant mathematical Newman-Kerr theory, that prolongs the external solution to the interior BH region. When I tried to describe my idea that the Universe is BH to the known Russian cosmologist, he replied: *"Your idea to use the Schwarzshild's solution in cosmology is unable to help the problems that you mentioned because this solution is not consistent with isotropy of the comoving space"* (private correspondence, June 14, 2008).

Of course, if we accept a *physical* solution inside of black hole, then my opponent is wright: such the solution should at least depend on the distance from the center of BH. However, our Universe, as it is well known, is uniform and isotropic on large scales. May be, we need change the BH picture that leads to singularities?

Here I would like mention the remarkable paper [8], where the very interesting idea of "gravastar" is proposed. The gravastar is a black hole with empty interior and a small but finite thickness (near to the Planck's length) of a fluid replacing both the Schwarzschild and de Sitter classical horizons. It is very interesting that last time a similar model with closed horizon, think massive shell, and without singularity was proposed by such known author in BH area as V.P. Frolov [9].

Many articles and books propose to a reader the same popular picture where the Universe is modeled by expanded 2D sphere *surface* without bounds. Because of that I came to the analogous 3D uniform and isotropic Universe geometry, and I tried to talk about this with Dr. Chernin and other scientists, but they won't even hear of it. Meanwhile, in Canada the group of prof. Afshordi [10] develops and publishes the models in which our the Universe is 3D brane due to the collapse of a 4D star into black hole.

But maybe the Universe model as 3D surface of a 4D ball in some external world (see above cited papers of Pathria and Good) cannot be *physically* consistent with the shell model? It turns out, it's not the case. My own investigation [11] based on the known results of General Relativity revealed the intriguing picture of BH formation from a body of finite size (not point-like one). Far from the collapse state pressure is positive and decreases continuously from the center of the body toward its bound. However, it turned out that during the object contraction (but before the collapse event) a new situation appears: The pressure distribution inside of the object is fully changing. An infinite bipolar pressure break point in the center appears which is forced out to the bound while the collapse is approaching. So, I came to the inevitable conclusion: the horizon is really a *membrane* even if one looks at it inside of BH!

All this allowed me to formulate the clear and consistent enough (as I hope) model and to verify its conclusions: I compared them with the observational data and standard model predictions. The exact results are described in my concluding publication [12] (see also my private web-site www.timeorigin21.narod.ru that I support regularly since 2007).

4 Is really the time course uniform?

As was noted above, the proposed model states the exact proportionality between the Universe age and size. Hence, any accelerated Universe expansion is impossible in such the model in spite of the 2011 Nobel Prize. I think that this conclusion was incorrect however the main discovery of the Supernovae lower luminosity was very substantial.

Interestingly, a number of theorists [13-16] independently came to the different cosmological models where (contrary to the standard model) the expanding Universe age also was proportional to its size. In each of these works their authors give near or equal calculation results that demonstrate that the model is close to observations.

The works [17] of the prof. Fulvio Melia group from Arizona University play the most important role. He just called his model: “The R_h = ct Universe”, i.e., the model where by definition the Universe radius is proportional to its age. The main contribution of Melia consists in hard and careful analysis of numerous different astrophysical data; as result, he came to the robust conclusion: such the model corresponds better to the observational data than Standard Cosmological Model.

References

[1] R.K. Pathria. *The Universe as a Black Hole (Вселенная как черная дыра) (Nature* ***240*** *(5379): 298–299).* DOI*:*10.1038/240298a0.
[2] I.J. Good. Chinese universes. Physics Today ***25*** *(7).* DOI*:*10.1063/1.3070923*.*
[3] Lee Smolin. The fate of black hole singularities and the parameters of the standard models of particle physics and cosmology. ArXiv:gr-qc/9404011v1 7 Apr 1994.
[4] Popławski, N. J. *(2010). Radial motion into an Einstein-Rosen bridge.* Physics Letters B***687*** *(2–3): 110–113.* DOI*:*10.1016/j.physletb.2010.03.029*.*
Popławski, N. J. *(2010). Cosmology with torsion: An alternative to cosmic inflation.* Physics Letters B ***694*** *(3): 181–185.* DOI*:*10.1016/j.physletb.2010.09.056*.*
Popławski, N. *(2012). Nonsingular, big-bounce cosmology from spinor-torsion coupling.* Physical Review D ***85*** *(10): 107502.*DOI*:*10.1103/PhysRevD.85.107502*.*
[5] V. I. Dokuchaev. Life inside black holes. Grav. Cosmol., vol. 18, pp. 65-69, 2012, http://arxiv.org/pdf/1203.0878.pdf.
[6] Yu. A. Lebedev, M. H. Shulman. MultiWorlds as the conscious choice of the super-World. “Nauka i zhizn ”, №7, 2011, Moscow (in Russian).
http://www.timeorigin21.narod.ru//rus_time/Lebedev_Shulman.pdf
[7] I. D. Novikov, V.P.Frolov. Black hole in the Universe. Uspehi, vol. 171, № 3. March of 2001.
[8] Pawel O. Mazur and Emil Mottola. Gravitational Condensate Stars: An Alternative to Black Holes. ArXiv:gr-qc/0109035v5 27 Feb 2002.
[9] Valeri P. Frolov. “Do Black Holes Exist?” ArXiv:1411.6981v1 [hep-th] 25 Nov 2014
[10] Razieh Pourhasan, Niayesh Afshordi, and Robert B. Mann. “Out of the White Hole: A Holographic Origin for the Big Bang.” ArXiv:1309.1487v2 [hep-th] 22 Sep 2013
[11] Michael H. Shulman. Usual collapse and unusual one.
http://www.timeorigin21.narod.ru/eng_time/Collapse.pdf
[12] Michael H. Shulman. “Time origin and universe uniform expanding”. American Journal of Modern Physics 2015; 4(2-1): 9-14 Published online January 28, 2015 (http://www.sciencepublishinggroup.com/j/ajmp) doi: 10.11648/j.ajmp.s.2015040201.12 ISSN: 2326-8867 (Print) ; ISSN: 2326-8891 (Online)
http://www.timeorigin21.narod.ru//eng_time/Universe_expansion_eng.pdf
[13] Shlomo Barak and Elia M Leibowitz. Cosmology and Astrophysics without Dark Energy and Dark Matter” (arXiv: astro-ph 0909.2581).

[14] A.Benoit-Lévy and Gabriel Chardin. Do we live in a Dirac-Milne Universe? (arXiv:0903.2446v1).
[15] A.Benoit-Lévy and Gabriel Chardin. Introducing the Dirac-Milne Universe. (arXiv:1110.3054v1)
[16] F.J.M. Farley. Does gravity operate between galaxies? Observational evidence re-examined (arXiv:1005.5052v1)
[17] Melia F. The Cosmic Spacetime. Is The Universe Much Simpler Than we Thought? (arXiv: 1205.2713v1);
Melia F., Shevchuk A. S. H., 2012, MNRAS, 419, 2579;
F. Melia and A.S.H. Shevchuk. The R_h = ct Universe. ArXiv:1109.5189v1 [astro-ph.CO] 23 Sep 2011;
F. Melia. The Gravitational Horizon for a Universe with Phantom Energy ArXiv:1206.6192v1 [astro-ph.CO] 27 Jun 2012;
F. Melia. Fitting the Union 2.1 SN Sample with the Rh = ct Universe.
ArXiv:1206.6289v1 [astro-ph.CO] 26 Jun 2012;
F. Melia. The Rh = ct Universe Without Inflation.
ArXiv:1206.6527v1 [astro-ph.CO] 27 Jun 2012;
F. Melia. Angular Correlation of the CMB in the Rh = ct Universe.
ArXiv:1207.0015v1 [astro-ph.CO] 28 Jun 2012;
F. Melia. CMB Multipole Alignment in the Rh = ct Universe.
ArXiv:1207.0734v1 [astro-ph.CO] 2 Jul 2012;
F. Melia. Proper Size of the Visible Universe in FRW Metrics with Constant Spacetime Curvature. ArXiv:1207.1332v1 [astro-ph.CO] 3 Jul 2012;
F. Melia. High-z quasars in the R_h = ct Universe. ArXiv:1301.0017v1 [astro-ph.CO] 23 Dec 2012.

APPENDIX 13. About black hole and information paradox

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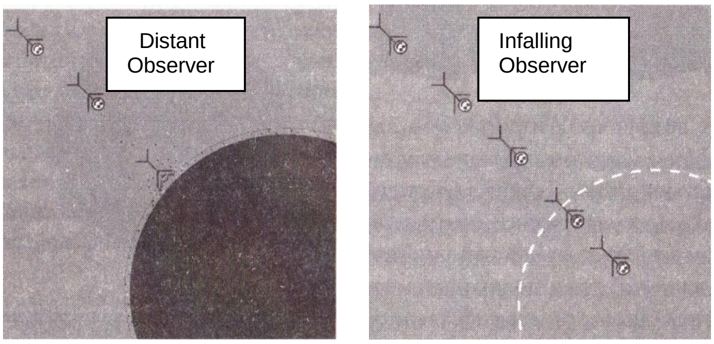
The black holes and their event horizons features are so far discussed in the scientific community. Particularly, as it was published, the so-called “information paradox”, was recently discussed on the special meeting in CERN. The infalling system description duality in two different reference frames (distant and infalling ones) and the conjectures about the event horizon structure are closely related with this paradox.

In the present publication I state that, in fact, such the duality and information paradox do not exist.

1. Duality of the infalling massive particle description

As it is well known, a particle infalling onto black hole (BH) in a distant reference frame “slows” its motion and finally turns out to be “frozen” at the horizon and never crosses it. However, in the Kruskal coordinate system that overlaps all the spacetime (not only external region) the infalling particle continues freely its motion into BH before it meets the central singularity. The “naïf” question appears: how can we reconcile the both descriptions?

In order to solve the situation L. Susskind proposed **[Susskind, 2008]** the idea of BH “complementarity” similar to the general Bohr complementarity principle. This idea states that the both descriptions (figs. 1a и 1b) are true. Any difference between them cannot be reached by some “superobserver” due to *the horizon existence*.



a) b)

Figure 1 **[Susskind, 2008]**.

However, regardless all the elegance of the complementarity idea I believe that it is redundant one. It turns out that, in fact, the particle infalling under the horizon is physically impossible!

My own investigation **[Shulman, 2009]** based on the known GR results has reached the intriguing picture of a BH creation when a material sphere of a finite size (not a point) is compressed. I choose the ratio ρ/ρ_0 (where ρ is the sphere actual density, ρ_0 is the critical density at which the gravitational collapse occurs) as the criterion of the state.

While this ratio is small, the pressure in the interior of the BH is strongly *positive* and is smoothly decreased from the sphere center to its periphery. However, the further compression of such the object near the collapse (at $\rho/\rho_0 \sim 0.7025$) leads to the essentially new situation: the pressure distribution in the interior of the BH is completely changed. It changes its sign at the center of the sphere and becomes *negative*, then inverts the sign while the *infinitely valued* bipolar rupture appears. As the ratio ρ/ρ_0 approaches unity this infinite bipolar rupture *is pushed* from the sphere center to its periphery; when the collapse happens this rupture turns to be exactly at the BH horizon and presents the *irresistible* barrier for any particle having the finite kinetic energy and trying to penetrate into the sphere interior (*under* its surface).

2. Dimensionality reduction

This fact forces me to propose the radical concept to describe BH in our Universe. It suggests that due to the gravitational collapse the *topology change* occurs at the BH boundary; the physical space itself disappears in interior of BH, and the black hole reduces to its boundary that takes the dimension 2 instead 3 (i.e., the dimensionality reduction occurs[32]).

Such the outlook is, in fact, not so surprising as one could expect. Since 70s of last century so-called “membrane paradigm” was commonly accepted in the BH theory. An *external* observer can strictly consider a BH as 2Dphysical membrane consisting in a viscous fluid having certain mechanical, electrodynamic, and thermodynamic features (**[Novikov and Frolov, 1989]**). These membrane features are determined by its surface gravitational and electric charges. In fact, this *mechanical* membrane comes to a dynamic *equilibrium* due to interaction between surface pressure, gravitation and centrifugal forces. *Electrodynamic* features of BH are specified by the complete similarity between the membrane and conductive sphere, and the electric field flux form of a charged particle near the event horizon of a non-rotating BH is the same one of this particle near above conductive surface. From the thermodynamic point of view the membrane surface area is similar to any usual body entropy: it increases or does not decreases (Hawking theorem). The membrane itself is defined by an effective temperature that is proportional to its surface gravitational charge. Finally, the famous Holographic Principle was formulated accordingly to which all the information is recorded on 2D-horizon. Maldacena in 1977 году established the complete isomorphism between these mathematical worlds **[Maldacena, 1998]**.

Note, recently the similar BH models were proposed where “interior region” and singularity were absent **[Mazur and Mottola, 2002]**, **[Mathur, 2013]**. The boundary between external Universe and BH are considered there as very thin (like planckian length), but finite.

I believe that the membrane paradigm is not an approximation, it is *absolutely exact*. All the BH mass is concentrated in this 2D region very uniformly, because there is no some difference depending on distance from the center. If the dimensionality reduction really takes place, then the complementarity conjecture is not needed, and holographic principle for BH turns out to be trivial statement.

3. The “information paradox” description

As it is known, S. Hawking theoretically discovered **[Hawking, 1975]** the BH thermal radiation. This radiation (as Hawking believes) is due to the virtual pairs “particle - antiparticle” creation; one member of the pair can tunnel under horizon, while another becomes the *real* one and is emitting into the external region. One thinks that this radiation leads to the paradoxical situation; e.g., the author of **[Anderson, 1996]** writes:

> Take a quantum system in a pure state and throw it into a black hole. Wait for some amount of time until the hole has evaporated enough to return to its mass previous to throwing anything in. What we start with is a pure state and a black hole of mass M. What we end up with is a thermal state and a black hole of mass M. We have found a process (apparently) that converts a pure state into a thermal state. But, and

[32] ‘t Hooft was first who used this term in the close sense **[Hooft, 1993]**.

> here's the kicker, a thermal state is a MIXED state (described quantum mechanically by a density matrix rather than a wave function). In transforming between a mixed state and a pure state, one must throw away information. For instance, in our example we took a state described by a set of eigenvalues and coefficients, a large set of numbers, and transformed it into a state described by temperature, one number. All the other structure of the state was lost in the transformation… In technical jargon, the black hole has performed a non-unitary transformation on the state of system. As you may recall, non-unitary evolution is not allowed to occur naturally in a quantum theory because it fails to preserve probability; that is, after non-unitary evolution, the sum of the probabilities of all possible outcomes of an experiment may be greater or less than 1.

Meanwhile, I propose below the arguments that (in my opinion) reject the information paradox existence.

4. Objections against the Hawking radiation mechanism

The Hawking radiation mechanism requires the tunneling of one virtual particle from the pair under the BH event horizon. However, as it was noted in the Section 1, there is the *infinite* barrier (i.e., the potential wall) at the "input" of BH; no particle can tunnel through such the wall. I have no any doubt that thermal Hawking radiation exists, but I believe, another mechanism is actual: in the BH gravitational field its effective radiation temperature (depending on the field stress) is determined by the surface gravitational charge and coincides with the Unruh temperature for an arbitrary gravity source; this temperature continuously transits to the Hawking temperature at the horizon (see **[Shulman, 2010]**). The BH entropy, Hawking radiation and temperature do not depend on the particle ability to penetrate into interior of BH.

5. When the "BH hair" appears

Even if we assume that a particle can penetrate into interior region of BH, this also cannot lead to the information paradox. In fact, very often the reference to the BH "no hair theorem" is made without account the presumption of BH *isolation*. We can read in the book **[Novikov and Frolov, 1989]**:

> Wheeler summarized the results of a large number of paper devoted to the final states of the black holes and formulated a conjecture that in its evolution to the stationary state, an isolated black hole sheds through radiation all those characteristics that radiation can remove. …
>
> An isolated black hole cannot be a source of any massive field since all the radiation modes are possible for such the fields … and accordingly to the Wheeler conjecture all from them have to be radiated during the transition into the stationary state.

If we now consider the quantum system penetration into an *isolated* BH, then it becomes clear that the BH isolation and stationarity turns out to be *disturbed*, and it will answer by a "*transitional"* radiation in order to *return* its stationarity. It is also clear that this *transitional* radiation *is not related* with stationary thermal Hawking radiation.

6. An infalling quantum system is *measured* by the BH external field

I am sure that the non-unitary evolution does not contradict to the quantum mechanics at all. In fact, the question is: does quantum mechanics give the reversible description only, or this is not the case.

Let us start from the classic mechanics. Very often one cites the irreversibility of the statistical mechanics against the reversibility of the Newton's mechanics. However, as I believe, in general the Newton Law *is not reversible*. The second law of Newton one usually writes as

$$F = m\ddot{q}$$

where F is the external force, m is the mass, $\ddot{q}$ is the acceleration. Here, of course, one does not take into account some medium resistance and irreversible energy loss at motion. However, in a more general case one should include, for example, a friction into this equation, then we have

$$F = m\ddot{q} + D\dot{q} + ...$$

that is just irreversible. The friction is a *reaction* of the rest parts of the Universe on the considered particle motion, at this an irreversible energy redistribution occurs, so a new irreversible term will appear into system Hamiltonian.

Moreover, generally quantum systems may be specified by the coherence that could disappear during the *decoherence* process. Particularly, the decoherence happens while a particle interacts with a field that "measures" the particle state **[Zurek, 2002]**:

> If a particle is present, excitations of the field will scatter off the particle. The resulting "ripples" will constitute a record of its position, shape, orientation, and so on, and most important, its instantaneous location… [The equation for the particle density matrix evolution] naturally separates into three distinct terms, each of them responsible for a different aspect of the effectively classical behavior. The first term – the von Neumann equation (which can be derived from the Schrödinger equation) – generates reversible classical evolution of the expectation value of any observable that has a classical counterpart … The second term causes dissipation. The relaxation rate is proportional to the viscosity due to the interaction with the scalar field. That interaction causes a decrease in the average momentum and loss of energy. The last term also has a classical counterpart: It is responsible for fluctuations or random "kicks" that lead to Brownian motion.

Namely, the influence of the last term destroys with time the quantum coherence and eliminates the non-diagonal density matrix components.

So, it is incorrect to think about a system in the pure state thate penetrates into an *isolated* BH. In fact, the BH field *measures* the infalling system, and the system transits into the mixed (decohered) state just before the penetration into BH; at this no conjectures are required about the event horizon structure like **[Almheiri et al., 2013]**, where authors suppose that "the infalling observer burns up at the horizon".

7. Can a distant observer see the BH growth?

I would like discuss one more interesting problem. Taking into account that signal propagation from the BH horizon up to a distant observer is infinitely slowed, it seems at first sight that a distant observer should see the BH just *in the first time point only*. However, the growing BHs absorb a *large amount of matter* that streams to the event horizon. When the accumulated mass around the horizon becomes dense enough, it collapses too. So the visible size of the BH increases still.

Acknowledgments

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References

[Almheiri et al., 2013] Ahmed Almheiri, Donald Marolf, Joseph Polchinski, and James Sully. Black Holes: Complementarity or Firewalls? arXiv:1207.3123v4 [hep-th] 13 Apr 2013

[Anderson, 1996] Warren G. Anderson. The Black Hole Information Loss Problem. http://math.ucr.edu/home/baez/physics/Relativity/BlackHoles/info_loss.html

[Hawking, 1975] S.W. Hawking. Particle creation by black holes. Comm. Math. Phys. 43 (1975) 199.

[Hooft, 1993] G. 't Hooft. Dimensional reduction in quantum gravity. arXiv:gr-qc/9310026v2 20 Mar 2009

[Maldacena, 1998] Juan Maldacena. The Large N Limit of Superconformal field theories and supergravity, arXiv:hep-th/9711200v3 22 Jan 1998.

[Mathur, 2013] Samir D. Mathur. What happens at the horizon? arXiv:1308.2785v1 [hep-th] 13 Aug 2013

[Mazur and Mottola, 2002] Pawel O. Mazur and Emil Mottola. Gravitational Condensate Stars: An Alternative to Black Holes. ArXiv:gr-qc/0109035v5 27 Feb 2002

[Novikov and Frolov, 1989] Novikov I.D., Frolov V.P. Physics of Black Holes (Dordrecht: Lluwer Acad. 1989)

[Shulman, 2009] M.H.Shulman. Usual collapse and unusual one. http://www.timeorigin21.narod.ru/eng_time/Collapse.pdf

[Shulman, 2010] M.H.Shulman. Entropy of a gravitational force source. http://www.timeorigin21.narod.ru//eng_time/Force_and_entropy_eng.pdf

[Susskind, 2008] Leonard Susskind. The black hole war. My battle with Stephen Hawking to make the world safe for quantum mechanics. Back bay books, Little, Brown and Company, 2008.

[Zurek, 2002] Zurek H. Woitech. Decoherence and the Transition from Quantum to Classical. Los Alamos Science, Number 27, 2002

APPENDIX 14. On the galaxy distribution depending on redshift

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We compare the observed galaxy redshift distribution with the theoretical predictions from the Standard Cosmological Model (SCM) and the Spherical Expanding Universe Theory (SEUT). We show that the assumption relative to the evolution of galaxy number versus density plays a more important role in the accuracy of these predictions that does the distinct geometrical features of each model.

1. Introduction

In the paper **[Barger et al., 2008]** the observed galaxy redshift distribution N(z) for several thousands of galaxies is shown (Fig. 1).

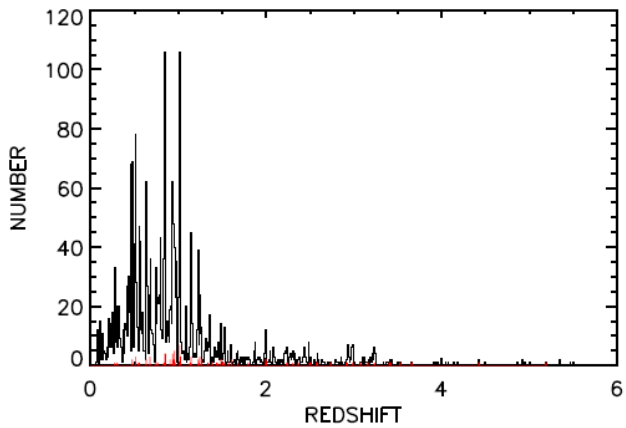

Figure 1. The observed galaxy amount dependence on redshift (**[Barger et al., 2008]**).

The comparison of this empirical data with theoretical predictions from various cosmological models is interesting, because the different models produce different predictions of the N(z) distribution, which allows us to distinguish between them. Indeed, there are many models to choose from, but in this paper, we consider only the expanding flat SCM model, and the expanding spherical SEUT model. Static models are not considered here, since they generally do not imply a redshift[33].

In any *expanding* model, each galaxy count N(z) at a given redshift z corresponds to a set of galaxies that remain equi-distant from an observer even as they all move away from the observer. In other words, all the galaxies are located on the same expanding spherical surface or "shell" (not necessarily a Euclidean one) centered at the observer. (Here we neglect any individual galactic normal motion, so all galaxies on a given observational shell remain on that shell as the Universe expands.) It is clear that the above galaxy count is the product of a *surface numeric density* n(z) and spherical surface area S(z):

$$N(z) = n(z) \cdot S(z)$$

[33] Sometimes a formal correspondence between a distance in the static Universe and redshift is declared as an heuristic principle (see **[Lopez-Corredoira, 2010]**).

When calculating the spherical area S(z), one must take into account two points: the Universal scale factor evolution and the type of its geometry. We will use the dimensionless measure θ of distance between the present-day observer and a galaxy:

$$\theta(t) = \int_{t}^{t_0} d(c\tau)/a(\tau)$$

where t_0 is the present-day Universe age, t is its age at some redshift z, and a(t) is a scale factor that depends on the Universe age, such that $a(t_0) = 1$. One can see that the expression under the integral (in the closed model) is equal to the central angle tangent of the expanding sphere, i.e., in the limit, to the angle itself at a small radius increment. Because of that, one can consider the integral as a total measure of a corresponding angle that is expressed in radians.

Actually, we are interested in the parameter θ(z), not in θ(t). The former depends on the redshift *z evolution as a function of time*. If we know this function, then we can express the surface area S(z) as is shown in Table 1.

Table 1
Bounded surface areas in the different Universe geometry models

Spherical (closed) model	**Flat model**	**Hyperbolic (open) model**
$S \sim [a(z)\cdot\sin\theta(z)]^2$	$S \sim [a(z)\cdot\theta(z)]^2$	$S \sim [a(z)\cdot\mathrm{sh}\,\theta(z)]^2$

In addition, we consider only two hypotheses relative to galaxy number count versus spatial density.

The *first* hypothesis assumes that the *total* galaxy count in the (observable) Universe remains constant during its evolution, i.e., it does not depend on the redshift value. In this case the galaxies are scattering while the scale factor a(z) is increasing, so the volumetric galaxy density is inversely proportional to a^3, and the surface density is inversely proportional to a^2. New galaxies do not appear, or their creation is compensated by the death of others. In this case the galaxy surface numeric density is

$$n(z) = n_0/[a(z)]^2,$$

where n_0 is the present-day galaxy surface numeric density, and a(z) is the scale factor.

The *second* hypothesis assumes that the galaxy *volumetric density*[34] and the surface density are constant), i.e., n(z) = const. This means that while the existing galaxies are scattering (as per Hubble’s law), new galaxies are born and fill the empty regions of the Universe.

(Most likely, both of these hypothesis are inexact. We wait for the ultimate answer from future observations and analysis.)

2. The N(z) galaxy redshift distribution in the SCM model

We consider first the standard cosmological model (SCM), in which the Universe is *infinite* and has a *flat* Euclidean geometry **[Wikipedia: Physical Cosmology]**. In such a model, the galaxy redshift distribution function N(z) is proportional to the square of–Θ(z), which specifies the distance between the observer and the galaxy. For its calculation,

[34] Note, the assumption that the volumetric galaxy density is constant was applied, for example, in the book **[Klapdor-Kleingrothaus and Zuber, 1997].**

existing computer programs (like http://www.astro.ucla.edu/~wright/CosmoCalc.html) can be used.

On the other hand, the distribution N(z) also depends on the hypothesis relative to the evolution of the galaxy count versus density. If we assume the first hypothesis (the total Universe galaxy amount is constant), then the scale factor does not affect the distribution, because the factor $[a(z)]^2$ is in the denominator of n(z) as well as in the numerator of S(z), i.e:

$$N_1(z) \sim [\theta(z)]^2$$

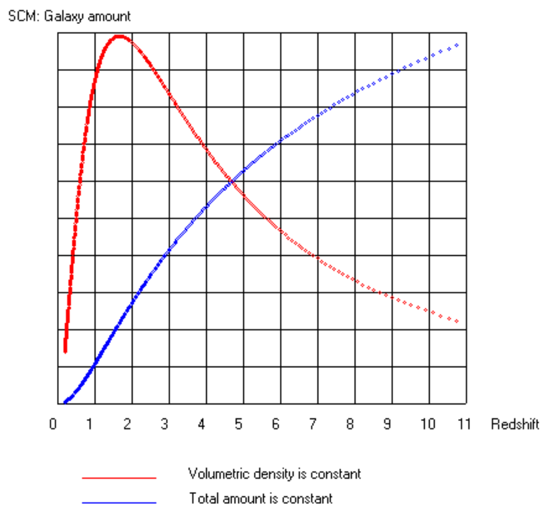

Figure 2.
Theoretical distribution of galaxy counts versus redshift N(z) in the SCM:
blue curve at a constant total Universe galaxy amount,
red curve at a constant volumetric density
(The curves are presented with different vertical axis scales)

But, if we assume the second hypothesis (i.e. the galaxy density is constant), we have to take into account the scale factor a(z), as follows:

$$N_2(z) \sim [a(z)]^2 [\Delta t(z)]^2$$

The results of the calculations are presented in Fig. 2. The first hypothesis corresponds to the *blue* curve while second one corresponds to the *red* curve (the curves are presented with a different vertical axe scale).

As shown in the figure, the SCM N(z) (blue) curve under the constant total galaxy count hypothesis increases monotonically with increasing redshift z (i.e., with the increase in distance between the galaxies and the current-day observer). This increase corresponds naturally to the increasing concentric spherical surface areas in the flat geometry model. Note this predicted curve does not at all correspond to the observed data (Fig.1). In contrast, the SCM N(z) (red) curve under the constant galaxy density hypothesis peaks at z=1.5. This is in qualitative agreement with the observed data (Fig. 1).

3. The N(z) galaxy redshift distribution in the SEUT model

Since 1993 one of us has developed an alternative cosmological model that is particularly described in the paper **[Shulman, 2007a].** This model is called the Spherical Expanding Universe Theory (SEUT). In SEUT, the Universe's evolution is represented by a

4D-cone having a linear generatrix (i.e., linear Universe radius dependent on its age). Any spatial cross-section of the cone at each time moment represents a closed 3D non-Euclidean hyper-surface of a 4D hyper-sphere (Fig. 3). The closure of the cone spatial cross-section geometry is due to the fact that in the SEUT the average matter density is higher than the critical density. Some effective predictions of SEUT, as compared with those of the SCM, are given in the works **[Shulman, 2007]**, **[Shulman and Raffel, 2008]**, **[Shulman, 2010]**.

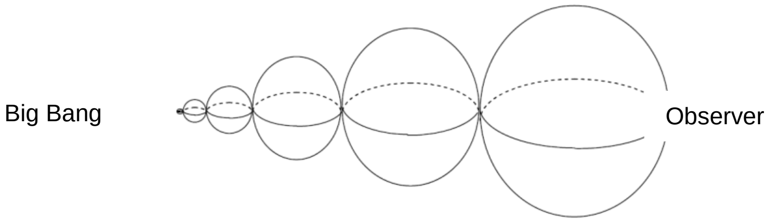

Figure 3.
The expanding close Universe model in the SEUT

Because of the spherical geometry of SEUT, no galaxy redshift distribution N(z) in the model can ever increase monotonically to infinity, since the finite spherical surfaces will impose a maximum peak at some redshift value .

In order to see this we start from the first hypothesis above that the total galaxy amount is constant. Then the Universe size evolution does not affect the redshift distribution N(z). To see this, consider first the similar (but simpler) 2D-problem: to determine the *perimeter length* bounding a part of a spherical surface when the sphere has a constant radius R (Fig. 4).

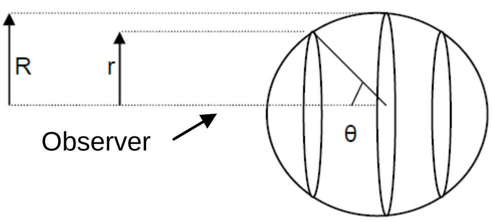

Figure 4.
Perimeter length evolution while one moves from left to right

As one moves away from the observer, the perimeter length 2πr of the “small” circumference increases first from zero up to maximal value 2πR, and then decreases again to zero. (In contrast, in the SCM Euclidean plane the circumference length increases *monotonically,* and is *unlimited.*) The “small” circumference radius r value depends on the linear central angle Θ (see Fig. 4), where Θ varies from 0 up to π.

In this 2D-analogy the observer is located at the left pole of the sphere while the observational galaxy is located at the *small circumference* specified by r = R sin Θ. In the SEUT 3D-situation we need to consider the point on a *small sphere* instead of a *small circumference*. If the small circumference *length* in the 2D-case is equal to the 2πR sin Θ, then in the 3D-case the small non-Euclidean sphere *area* will be equal to $4\pi R^2 \sin^2\theta$. At θ = π/2 this area is maximal and is equal to the usual 3D-sphere area. In this case, the area values alone determine the galaxy counts that are localized on the sphere corresponding to any given redshift z:

$$N_3(z) \sim \sin^2\theta$$

As was shown in our work **[Shulman and Raffel, 2008]** the angle θ(z) in radians is:

$$\theta(z) = \ln\,[a(0)/a(z)],$$

where a(z) is the Universe scale factor[35] at a current redshift value z. So, one can build the *red* curve in the Fig. 5 step by step by incrementing z and calculating a(z), θ(z) and area S ~ $[a \sin \theta]^2$ of the small non-Euclidean sphere.

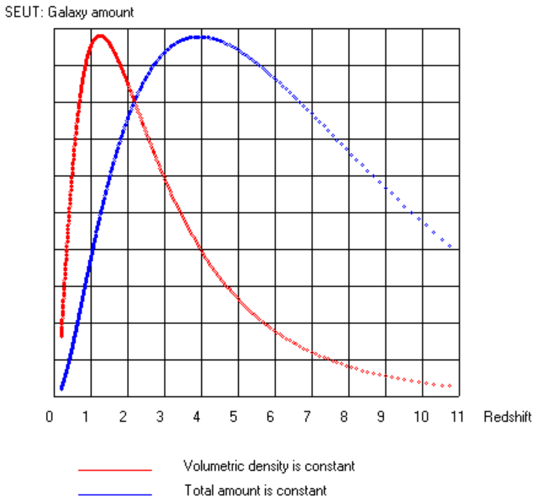

Figure 5.
Theoretical distribution of galaxy count versus redshift N(z) in the SEUT:
Blue curve at a constant total Universe galaxy amount,
Red curve at a constant volumetric density
(The curves are presented with different vertical axis scales.)

But if we assume the second hypothesis in which the galaxy spatial density is constant, then we also have to take into account the Universe size at each given z. This requires that the surface area factor above be multiplied by the square of the current Universe scale factor:

$$N_4(z) \sim a^2 \sin^2 \theta$$

The distributions corresponding to both hypothesis in SEUT are presented in Fig. 5. As would be expected, the maximum of the *red* curve (which takes into account the scale factor variation) is smaller (z=1.2) than the maximum of the *blue* curve (z=4). In this case, the red curve maximum is closer to the actual data (Fig. 1) than the blue curve, indicating that the constant galaxy density assumption is preferred within the SEUT.

4. Conclusion

Our results show that the characteristics of the Universe galaxy evolution (i.e. constant galaxy amount versus constant galaxy density) plays a more important role in the N(z) prediction than the model geometrical features (i.e. flat Euclidean SCM metrics or spherical SEUT metrics).

In this context, the hypothesis that *the total Universe galaxy count* remains constant during its evolution does not produce qualitative agreement between the actual observed N(z) distribution and the predictions from either model. (Note these predictions also differ between themselves).

[35] In the SEUT the scale factor a(z) is proportional to the current Universe age.

At the same time, the alternative hypothesis that the galaxy spatial density is constant during the Universe's evolution produces N(z) predictions in both models that are close to the actual observed N(z) distribution.

References:

[Barger et al., 2008] A. J. Barger, L. L. Cowie, W.-H. Wang. A HIGHLY COMPLETE SPECTROSCOPIC SURVEY OF THE GOODS-N FIELD. ArXiv:0812.2481v1 [astro-ph] 12 Dec 2008

[Klapdor-Kleingrothaus and Zuber, 1997] H.V.Klapdor-Kleingrothaus, K.Zuber Teilchenastrophysik. B.G. Teubner GmbH, Stutgart, 1997

[Lopez-Corredoira, 2010] Lopez-Corredoira M. Angular size test on the expansion of the Universe. arXiv:1002.0525v1 [astro-ph.CO] 2 Feb 2010.

[Shulman, 2007a] M.H. Shulman. Cosmology: a New Approach. Available at: http://www.timeorigin21.narod.ru/eng_time/Cosmology.pdf

[Shulman, 2007b] M.H. Shulman. On the supernovae low luminosity problem. 2007. Available at: http://www.timeorigin21.narod.ru/eng_time/On_supernovae.pdf

[Shulman and Raffel, 2008] M.H. Shulman, G.A. Raffel. On the Oldest Photons Phenomenon. Available at: http://www.timeorigin21.narod.ru/eng_time/Oldest_photons_eng.pdf

[Shulman, 2010] M.H. Shulman. Universe expansion and main spectral peak of CMB. 2010. Available at: http://timeorigin21.narod.ru/eng_time/Main_peak_eng.pdf

[Wikipedia: Physical Cosmology] http://en.wikipedia.org/wiki/Physical_cosmology

APPENDIX 15. Entropy of a gravitational force source

© M.H. Shulman, 2010 (shulman@dol.ru)

(August 2, 2010. Updated: September 14, 2015)

I analyze the connection between a gravitational force source and its entropy. The famous **“Bekenstein bound”** or **universal entropy bound** is generalized.

1. Introduction

In the past century J. Bekenstein established that black hole (BH) should have great entropy proportional to its event horizon area. He wrote in [**Bekenstein, 2003**]:

> … a solar mass black hole has an entropy larger [20 orders] than that of a solar mass star which might have been its predecessor. But why should the holes’s entropy be the larger by many orders of magnitude? Boltzmann’s principle that a system’s entropy is the logarithm of the number of microscopic configurations compatible with that system’s macroscopic properties, together with the “no hair” principle, suggests that black hole entropy is large because a black hole’s aspect cannot tell us precisely which type of system gave rise to it. This extra lack of “composition information” over and above that about specific microscopic configurations may be what makes black hole entropy large. A black hole stands for a large amount of missing information.

The author of the recent famous paper **[Verlinde, 2010]** has shown that the connection between gravitation and entropy can exist not only for BHs, but for “usual” bodies having a state far from gravitational collapse. He introduced an imaginary spherical screen bounded such a body and supporting some holographic information about body mass distribution. He supposed also that gravitation is not fundamental force, so it can be obtained from entopic gradients while the screen radius is changing.
However, the assumption on such a “holographic” screen existence supporting a specific information does not seem to be enough well-grounded[36]. On the other hand, the evident connection between gravitation and entropy does not obligatory lead to the entropy’s priority. For example, the authors of **[Porcelli and Scibona, 2010]** show that, by using the gravitational dynamics to reproduce the thermodynamic force equation, there is no way to establish the entropic origin of gravity, because the results can be seen the other way around.

In the present paper I argue that the gravitational field can provide the entropy gradients not only for BH, but also in the case of a typical massive body.

2. Field of a central-symmetrical force source and entropy

A mass M creates *central-symmetrical* gravitational field having the potential $\Phi(r) \sim 1/r$. As it is known, the field at a distance r from such a source is determined by the part of the mass located *inside* the sphere having such the radius. Using the approach for BH, we can formulate the statement by another way: *the field at the distance r is generated by equivalent surface gravity σ for the sphere of such the radius, while the same value of σ can correspond to a great number of the real mass configurations inside the sphere*.

In other words, an observer connected with a test particle has always a real uncertainty of the mass distribution, because the interaction between the central source and the particle simply is not physically able to provide more information about it. At a given mass value the

[36] See, particularly, the interesting work **[Myung et al., 2010]**.

uncertainty is depending on the distance between the test particle and the source center. As the gravitational field intensity can be expressed through the equal surface gravity, the entropy corresponding to the sphere surface is equal to the (dimensionless) sphere area.

One can formulate this in terms of thermodynamics. As it is known, a small increment of energy/work ((dW) may be written as the product of generalized force and increment of generalized coordinate. For example, it may be the product of a usual force (e.g., gravity) and displacement (dW=F·dx), or the product of a (gas) pressure and a volume increment (dW=p·dV). But it may also be the product of a temperature (the energy per the surface unit) and a surface increment (dW=T·dA), so, the surface area can play role of entropy.

Let us consider (like Bekenstein) a situation when a test particle falls onto a gravitational field source. At a time moment the particle will transverse an imaginary sphere having some radius that surrounds the source (not black hole in our case). For another test particle outside of this sphere the source mass seems to be increasing due to the first test particle mass accounting. So, the amount of the mass distributions inside the sphere increases too. I.e., the first test particle brings its entropy into the sphere like a situation when a black hole absorbs a particle.

3. Unification of description

Let us to unify the formulas for temperature and entropy that describe both the cases – usual massive body having mass *M* and radius and BH having the same mass *M* and radius $r_G=2GM/c^2$, where *G* is the gravitational constant.

For *the temperature* one can use the Unruh formula (see (**[Good, 2006]**).

$$T_U = (\hbar/2\pi ck)a$$

where *a* is acceleration, *c* is the velocity of light, *k* is Bolzman constant, *ħ* is Plank constant.

This temperature[37] is just analogy of the Hawking temperature at the BH's event horizon

$$T_H = (\hbar/2\pi ck)\sigma$$

where *σ* is the surface gravity (the gravitational acceleration experienced by a body at the BH's event horizon).

Let us now determine the *entropy* dependence. For the Swhwarzschild black hole the entropy is proportional to the event horizon area. The Verlinde's holographic horizon entropy is also proportional to its area, however, this leads to the fundamental problem which was viewed by Verlinde himself: if the proportionality factor was the same, then the BH's entropy had to be *extremely much less* than an usual body's entropy, because its gravitational radius is much less!

To eliminate this problem I propose to multiply this proportionality factor by the additional ratio (ρ/ρ_{cr}), where ρ is the actual body density, ρ_{cr} is the "critical" density of the collapsed body with the same mass. For example, this ratio for Sun is near 10^{-16}, for Earth it is equal to 10^{-26} (see also Table 1). As it is clear such the ratio effectively increases the body entropy while it approaches to the collapse state. In addition, it naturally takes into account the direct correlation between the entropy and the mass under imaginary sphere area A. Thus, the proposed formula for arbitrary body (including a BH) entropy S is:

$$S = c^3 A\rho/4G\hbar\rho_{cr}$$

[37] Its numerical value at the surface of any body in our Universe is between 10^{-15} and 10^{-30} K.

Note that the area A is proportional to the square of the sphere radius, while the density ρ is inversely proportional (at a given mass) to the radius cube. Hence, finally the entropy is inversely proportional to the radius, i. e., *it rises while the radius decreases*. We are coming to the remarkable result: the mutual attraction process of massive bodies *increases their total entropy*, i.e., corresponds to the natural time evolution due to the second law of thermodynamics.

One can come to the same result while considers the “energetic” aspect: a test particle attracts to a gravitational source and so minimizes the gravitational potentials difference between its current location and the source surface. When the test particle rotates with a constant velocity around the source, then it minimizes the algebraic sum of the gravitational energy and the kinematic one, due to that the rotation occurs at a stationary orbit.

4. Conclusion

So, we come to the next important conclusions.

- For any massive particle the natural entropy gradient along the sphere gravitational radius appears. The more, such a phenomenon can be possible for arbitrary source of a central-symmetrical force. In this sense the connection between a “fundamental” force and entropy is not specific for the gravitational interaction. Because of that the Verlinde’s conception does not seem to be valid, in my opinion.
- The proposed generalization of the entropy formula allows us to predict entropy as for usual body state as well as for BH having the enormous entropy at the event horizon. This naturally explains the famous **“Bekenstein bound”** or **universal entropy bound** origin, and needed amendments are introduced to the entropy value in all the range of astrophysical objects (see Table 1 below).
- The gravitational forces define the natural evolution direction corresponding to the second law of thermodynamics.

Table 1

Ratio (ρ/ρ_{cr}) for different astrophysical objects

Object	Mass M (kg)	Radius R (m)	Gravitational radius R_G (m)	$(\rho/\rho_{cr}) = (R_G/R)^3$
Earth	$6{\cdot}10^{24}$	$6{\cdot}10^{6}$	10^{-2}	$\sim 10^{-26}$
Sun	$2{\cdot}10^{30}$	$7{\cdot}10^{8}$	$3{\cdot}10^{3}$	$\sim 10^{-16}$
Milky Way	$3{\cdot}10^{42}$	$\sim 10^{19}$	$\sim 10^{15}$	$\sim 10^{-12}$
Universe	$\sim 10^{53}$	$\sim 10^{26}$	$\sim 10^{26}$	~ 1

References

[Bekenstein, 2003] Jacob D. Bekenstein. Black holes and information theory. arXiv:quant-ph/0311049v1 9 Nov 2003

[Good, 2006] Michael R.R. Good. Thermalizing the Vacuum. Available at: http://www.unc.edu/~mgood/research/Unruh.pdf

[Myung et al., 2010] Yun Soo Myung, Hyung Won Lee, and Yong-Wan Kim. Entropic force versus temperature force. arXiv:1006.1922v1 [hep-th] 9 Jun 2010.

[Porcelli and Scibona, 2010] Fernando Porcelli and Giancarlo Scibona. On the Black Hole’s Thermodynamics and the Entropic Origin of Gravity. Arxiv: 1011.0895 [gr-qc].

[Verlinde, 2010] Erik Verlinde. On the Origin of Gravity and the Laws of Newton. arXiv:1001.0785v1 [hep-th] 6 Jan 2010.

APPENDIX 16. On the photon aging paradox

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1 Standard cosmological model and the photon observation

At the beginning of the 20th century the astronomers started to investigate the radial velocities of the distant galaxies using their spectra measurement. They revealed that the overwhelming majority of galaxies *recess from us*, so their spectra have a redshift. One believed that a spectrum shift could be due to *kinematic* factor, i.e., a *relative velocity* of a galaxy only.

However, in 1927 G. Lemaître **[Lemaître, 1927]** predicted such the phenomenon in the expanding Universe using General Relativity. Unfortunately, he also used the term "Doppler's effect", though in fact its model was based on the *distance* to a galaxy at the emission time, not on its *relative velocity*. This model states that the light propagates along a geodesic world line where 4-interval $ds^2=c^2dt^2 - a^2(t)dr^2$ is equal to *zero*. Then $|dt| \sim a(t)dr$, in other words, *time* "dilates" too during the Universe expands *spatially*. So, Lemaître considered the emission and observation stages of the leading edge and the end of the wave packet and showed that the observation duration is longer than the emission one, i.e., a redshift of light should be present.

The observational data confirm the effect of the time dilation (see, for example, **[Longair, 2008]**, Sect. 5.5.1). For instance, the hypothetical standard time period between the basic stages of the supernova brightness curve turns out to be proportional to the distance from Earth. Thus, the explanation of redshift given by Lemaître is now the conventional one.

2 Contradiction and doubt

However, such the explanation enter in the fundamental contradiction with the Universe energy conservation law: if the photon's energy decrease during the Universe evolution (due to wavelength and time period dilation), then where this energy comes to? The Lemaître's theory predicts nothing about this, though the different possible empirical explanations were supposed (and refused).

Also I find reasonable another question. In any case a photon flies away from a source, and our photon does not know *why namely* the distance between it and an observer decreases, is its velocity due to galaxies recession or peculiar galaxy motion (or their combination). So, what we have to do with the "true" Dopplers's effect due to relative moving off? If we do not have to take it into account, then why? If we have to account it, then how to combine the velocity and scale factor?

It is interesting to note that author of the recent work **[Melia, 2012]** found the same expression for the cosmological redshift in 6 different *static* metrics without the Universe expansion, so we could ask, is there a *real* connection between redshift and a time-space dynamics?

Furthermore, in the work **[Chodorowski, 2011]** its author gives the link to the paper **[Bunn and Hogg, 2009]** where was pointed out that in order to settle properly this problem, one has to transport parallely the velocity four-vector of a distant galaxy to the observer's position. Performing such a transport along the null geodesic of photons arriving from the galaxy, they found that the cosmological redshift is *purely kinematic*. Also, Chodorowski in his own publication argues that one should rather transport the velocity four-vector along the geodesic connecting the points of intersection of the world-lines of the galaxy and the observer with the hypersurface of constant *cosmic time*. He also shows that the so-called *proper* recession velocities of galaxies, commonly used in cosmology, are in fact radial components of the galaxies' four-velocity vectors.

3 The critical analysis of the Lemaître's model

The effect predicted by Lemaître was implicitly deduced from one important *assumption*: one supposed that the light oscillations just have a classical (non-quantum) origin, and an observer is hypothetically able to receive some "instant" signals corresponding (*independently* one from another) to the maximums of wave pocket and then determine the time interval between them. However, one can doubt such the model – the light carries by the photons whose discrete nature was discovered at the beginning of the 20th century. So, we can suggest that physically the maximum's and minimum's locations (or two adjacent maximums) of the same time period are *dependent* on time between them and are some entity.

If so, then the single photon could be considered as some *pulsating* object (with constant or evolving wavelength) moving from a source to an observer. Furthermore, the evolution model should be specified. Let us consider the simplest versions:

(a) the wavelength and time period of a photon "*dilate*" during the Universe evolution;
(б) the wavelength and time period of a photon *do not change* during the Universe evolution.

The case (a) just corresponds to the Lemaître's model and to conventional approach, however, the unsolved problems (energy loss and accounting of purely kinematic Doppler's effect) remain. In the case (b) the both problems are eliminated: the photon energy (and full the Universe energy) are conserved, and redshift could be explained by purely kinematic Doppler's effect.

If the cosmological redshift is indeed due to the *relative* velocity of the recessing galaxies, then on can easily answer another FAQs (Frequently Asked Questions).

Can a recession velocity even of the most massive object become close to the velocity of light? Of course, yes, because this velocity does not represent something extraordinary, it may be simultaneously very small for another observer, it is the *relative* effect.

And what about the very distant objects which go away and have a *superluminal* velocity? Answer is: nothing, because after they gain the velocity of light its photons were not able to reach an observer that resides on Earth, i.e., the object leaves our events horizon.

Sometime one states: *recently the astronomer were able to observe the very distant objects (with redshifts more than 10) whose radiation should be generated just after Big Bang. But these objects could not locate too far one from another because of small size of the earlier Universe, so, the photons between them could not travel so long*. However, it is not true: the light cone (and events horizon) exists always in the Universe, i.e., there are always a hypothetical objects whose radiation goes to us infinitely long.

4 Photons and alternative cosmology

I noted above that the Lemaître's model of "dilating" light wave contradicts fundamentally to Energy Conservation Law. I proposed to eliminate this contradiction using the "constant" photon's model.

Meanwhile, since 1993 I develop the alternative cosmological model where the Energy Conservation Law is *not correct*. I state that our Universe is a black hole in an external hyper-universe from which it absorb the energy and matter (it is the *real* reason of our Universe's expansion). In this cosmological model the mass and energy of any particle (including photon) increases proportionally to the Universe's age (see **[Shulman 2004, 2008, 2011]**).

It turns out that in this model we also have to use a constant wavelength of light quanta during all it's the travelling time. However, the photon's *energy* linearly increases with time due to Planck's parameter *h* evolution (not due to a space-time parameter's evolution!). Thus, the term "Planck's constant" turns out to be incorrect in this model.

Acknowledgement

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References

[Bunn and Hogg, 2009] Bunn, E. F., Hogg, D. W. 2009, AmJPh, 77, 688 (BH9)

[Chodorowski, 2011]. Michał J. Chodorowski. The kinematic component of the cosmological redshift**,** arXiv:0911.3536v3 [astro-ph.CO] 8 Mar 2011

[Lemaître, 1927] G. Lemaître. Un Univers homogene de masse constante et de rayon croissant rendant compte de la vitesse radiale des nebuleuses extra-galactiques. Annales de la Societe Scientifique de Bruxelles, Vol. 47, p. 49, April 1927.

[Longair, 2008] Malcolm S. Longair. "Galaxy Formation". Second Edition. 2008. Springer-Verlag. Book is available for viewing on Google Books at the link below http://books.google.com/books?id=blzugw-83nAC&printsec=frontcover&dq=galaxy+formation+longair&source=bl&ots=579mE49hed&sig=hLsSrgPN2rA6yoAWCP5yqXgPphk&hl=en&ei=cPXOS6zCOqDMMeHUne8P&sa=X&oi=book_result&ct=result&resnum=3&ved=0CBQQ6AEwAg#v=twopage&q&f=false

[Melia, 2012] Fulvio Melia. Cosmological Redshift in FRW Metrics with Constant Spacetime Curvature, arXiv:1202.0775v1 [astro-ph.CO] 3 Feb 2012.

[Shulman, 2004] Shulman M.H. Variations on Quantum Theory (in Russian). Moscow, Editorial URSS, 2004. Available at http://timeorigin21.narod.ru/rus_quantum/Variations.pdf The brief English presentation is available at http://timeorigin21.narod.ru/eng_quantum/Eng_variations.pdf

[Shulman, 2008] Shulman M.H. How to transit to quantum mechanics from classical one. Is available at http://timeorigin21.narod.ru/eng_quantum/How_to_transit_eng.pdf

[Shulman, 2011] M. H. Shulman. Time origin and Universe uniform expanding. http://www.timeorigin21.narod.ru/eng_time/universe_expansion_eng.pdf

APPENDIX 17. Entropy and evolution

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(November 11, 2012. Updated: January 26, 2013)

A system openess is the *required* condition of its *progressive* evolution; it means that the regular input and otput *energy* flows exist. Also, the input *entropy* flow has to be less than the ouput one. However, this condition is sufficient *only to support* an obtained level of remoteness from the thermal equilibrium state, while it is needed something yet to *complicate* the system ordering. Namely, a rule of choice must exist in the system phase space that enables a set of *stable* points or domains and disables other points and domains. When the both conditions present, a progressive evolution really occurs and leads to a structural changes and a new rules of choice appearance. I consider below two fundamental examples of such systems: 1) whole Universe, and 2) Earth.

So, a *material* system evolution is based on Nature's Laws. However, these Laws are *objective ones*, but they aren't *material*, i.e. they cannot be attribted by time-space parameters and cannot transport the energy and momentum. The such Laws existence forces us to suppose that an *other* level of the Reality exists which has to be (in a sense) an *external* one relative to our Universe.

Introduction

There exist two principal trends in our Universe: the first one consists in the entropy (and chaos) rise anywhere, while the second one leads to the ordered structures creation. One can see this on Earth (including the human activity phenomena). Also, all the Universe is clearly an example of the system that regularly moves avay from the "heat death" state. So far the physicists usually imagine our Universe as an *isolated* system, so the energy and matter cannot leave it and come into it. Because of that one deduces the Second Law of Thermodynamics that quite contradicts to the real Universe evolution.

However, one often states that the Universe cannot be considered as an isolated system due to the gravitation effects, and this may explain a complicately ordered structures and processes existence that clearly contradicts to the Second Law. Unfortunately, this statement is rather "a carpet under which one sweeps up a trash" (as Feynmann said), it explains noting and cannot help us to understand the evolution origin.

How the Universe entropy does change?

Wee need in the entropy trend picture to understand the Universe evolution hystory. I believe that one has to recognize the evident fact: *the Universe entropy decreases (not increases*) with cosmic time. The problem remains "only" how one can theoretically explain it.

Since 1993 I develop a new cosmological model that differs from the standard one, see **[Shulman, 2011]**. In this new model our Universe represents the black hole (as I know, Jh. A. Wheeler was one of pioneers of such the idea, see **[Smolin, 1994]**), which *irrevercibly* expands due to the matter and energy absorption from an external 4D World. The time course itself is just the Universe radius increment that refers the events chronology like a tree growth rings.

So, in the proposed model at least a *regular input energy flow* into the Universe is accounted. However, the model also provides the opposite process: the energy *elimination*. It seems to be *impossible* due to black hole definition. However, there exist the *internal* black holes in our Universe. Some decades ago the astrophysicists reval that there are supermassive black hole inside of the galaxy cores. The total entropy of these supermassive black holes is 20 orders larger than all the rest of the Universe, see **[Egan and Lineweaver, 2009]**. Their surface (event horizon) temperature is practically equal to zero, i.e. is less than the average Universe temperature. Hence, they are the perfect heat absorbers. Accounting all that we can believe that “the rest” of the Universe is thermodinamically *open* system, not isolated one.

Why may we suppose that the *output* entropy flow from our Unoverse is *larger* than the input one into it? The each internal black hole entropy is proportional to its freedom degree number, i.e. to its dimensionless surface area (the number of 2D cells having plankian size). If our Universe is the black hole in an *external 4D World*, then its entropy should be equal to the number of *3D* plankian cells. Hence, the our Universe entropy *increasing* with time will be proportional to the 3th power of its size, while entropy decreasing will be be proportional to the 2th power of an internal black hole average size. However, it is possible that the blac hole *amount* also increases with time; for example, if it is proportinal to the Universe current volume, then total entropy *decreasing* rate will be *positive*.

So, we can suppose that our Universe (without all internal black holes) progressive evolution is due to a transit flows of the negative entropy.

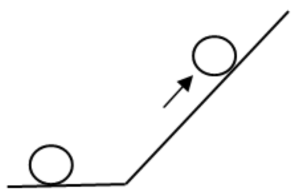
The isolated and open system evolution

The energy redistribution during interactions can lead to a systems evolution. Corresponding the intensity and type of interactions to a current statistical system state we can describe evolution using positive and/or negative feedback mechanisms that just define this evolution.

For example, let an isolated system be consist in two subsystems, where each of them initially is in the thermal equilibrium state and is specified by an own temperature. *If* both subsystems have a *positive* heat capacity, *then* a subsystem having the higher temperature will send the heat to the system having the lower one, and the temperatures will tend to be equal. One can say that the total system is regulated by a *negative* feedback that stabilizes its state and maximizes its entropy. Contrary, *if* both subsystems have a *negative* heat capacity (for example, stars whose temperature *increases* with energy emission), *then* a *positive* feedback emerges in such the system, so a system deviation from equilibrium leads to a further deviation growth. Because a temperature cannot rise up to infinity due to energy limitation the system stabilisation is probably the most general case (Le Chatelier’s principle), i.e. it generally tends to the equilibrium state (“heat death”).

Another case is an *open* system that is included as intermediate part between an energy source and an absorber. The energy coming into our system from an *external* source creates in it a local energy gradients, i.e. deviates it from the thermal equilibrium state. If an effective energy elimination was absent, then emerging relaxation flows returned our system to the equilibrium, however, if such the energy elimination is present, then it can assure the conservation and even increasing of the remoteness from the equilibrium state.

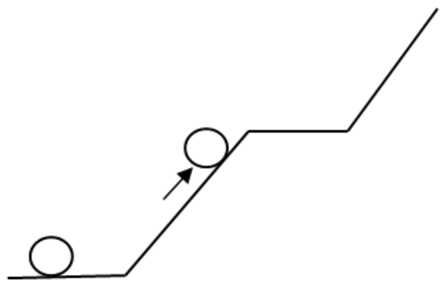
Let us consider how a regular negative entropy assures the remoteness from the equilibrium state. We can compare the system position in the phase space at the equilibrium with a ball disposed at the bottom of a mount (miminimal energy, maximal entropy).



If the ball is regularly pushed by an external power (as the flash points out) and the average energy is large enough, then it starts to ascend onto “energetic” mount while the system potential enegy will increase and its entropy will decrease. Of course, a type (accidental or systematic) and irreversibility of the ascending depend on the energy inflow parameters.

So, the regular yielding of the negative entropy solves the problem of the open system remoteness from the “heat death” and statistical homogeneity state. But is it enough to increase the *ordering* level of the matter structure?

In the above figure there exist a linear connection between a potential energy increment and its entropy decrement, and evolutions turns out to be reversible. If the accumulated system energy decreases, then evolution inverses. However, for ordered systems a *stable* states exist, so the system resists to any deviation from them. When the potential energy changes, the entropy of such the system changes essentially by a *nonlinear* way due to creation of a feedback contours. A simple illustration is shown below where there is only *one* intermediate stable state (the bar). The states stability can be in general obtained using a numerous feedback contours.



The considered situation shows that the main assumption – “all microstates have a priori the *equal* probabilities” – turns out to be *incorrect*. Because of that a numerical estimate of some very important *macrostate* turns out to be *incorrect* too. This statement will be considered below with two fundamental examples: the Universe evolution and Earth’s one.

The Universe evolution

Our Universe evolution is, of course, connected with its structure complication, elementary paricle, atoms, and molecules creation. The more and more heavy chemical elements appeared consequently. A very intersting description of cosmogenesis one can find in a numerous literature (see, for example, the famous bestseller **[Weinberg, 1976]**). But now another thing is important for us. *Why* did it occur what is did? Precisely saying, could it occur something another including some kind of chaos, with minimal ordering (even far from the equilibrium state)?

This question is not so senseless as one may think. It turns out that many nature laws and our Universe features seem to be *fitted* excluisively fine in order the lattest were just such as it is. “The observed values of the dimensionless constants such as the fine-structure governing the four fundamental interactions are balanced as if fine-tuned to permit the formation of commonly found matter and subsequently the emergence of life. A slight increase in the strong nuclear force would bind the dineutron and the diproton, and nuclear fusion would have converted all hydrogen in the early universe to helium. Water, as well as sufficiently long-lived stable stars, both essential for the emergence of life as we know it, would not exist. More generally, small changes in the relative strengths of the four fundamental interactions can greatly affect the universe's age, structure, and capacity for life." (see **[Wikipedia])** There exist also many other similar facts.

This problem is investigated since 20th century, the attempt to its solution was named "Antropic principle". One of its formulations states that there exists a set of universes (a multiverse), but only in such universe as our one there are observers who can observe it.

As I believe, this explanation is not satisfactory. In fact, we have to consider a more fundamental things than even such the "fine tunning". For example, let us calculate a probability for some amount of elementary particles to be aggregated into *absolutely identical* atomes and molecules. If we were depart from the Second Law of Thermodynamics only, then this probability were negligible. The more, before the atoms appeared in the early Universe, why had we to believe that the same chemical substances will be consequently born in the very distant Universe regions and occupy the cells of the periodic table (yet not "existing")? Only now we know the remarkable laws of Quantum Mechanics that determine such the facts. Hence, the nature's laws provide also several positive feedbacs that *select* some stable structures and forbid another ones, not only negative feedbacs.

So, what happens? Our open system (Universe) regularly gets the energy from outside. Due to this the energy gradients in the system constantly increase, and the resources of energy are accumulated (for example, in the stars and galaxy cores)[38]. During this process "the representation point" in phase space moves away from an initial position. This way contains some "special" points and domains where a non-trival *selection rules* act. These rules action sharply changes "prior probabilities" that could be found without corresponding rules knowing.

The Earth evolution

In the proposed model our Universe is thermodynamically *open* system, a transit energy flow "blows" on it. The very similar model is held for the system of lower level: the Sun energy (the visible light photons having small entropy) comes onto Earth and then reemits into Space in the form of infrared thermal photons having large entropy. Beside the Sun surface temperature attempts 6000 degrees Celsius, while the Space temperature is near to zero. Because of that a giant *negative* entropy flow passes trough Earth, see **[Penrose, 1989]**. So, the Sun is very powerful source of "negaentropy" (and structural information[39]) for us.

Note, a large supply of the potential energy and highly ordered matter is accumulated on Earth (for example, oil, etc.). Of course, this model is true in general for any system "star – planet".

The same progressive evolution schema (like Universe evolution) works again. It led to the Life creation on Earth (as we know, the photosynthesis is its important condition). Schrödinger **[Schrödinger, 1955]** stated that the negative entropy inflow into a living organism is *required* for it life. The regular energy recharge is transformed to the useful work increment (and partially to the unused heat) that services the organism and supports its state far from the equilibrium. But this is a *possibility* only! However, what about of the *sufficience* condition?

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[38] The system internal energy change is formed by two components. The first one is the *heat change*, and the second one is the *work change*. The first component corresponds with disordered (chaotic) energy of an individual freedom degrees while the second one corresponds to their *correlated* energy. The famous author of **[Brillouin, 1961]** wrote that *a system which is able to produce a mechanical work (or a work due to electrical forces existence) has to be considered as a negaentropy source. A spiral spring, a lifted weight, and a charged battery can be considered as such the system.*

[39] As I found, the total capacity of the informational channel from Sun to Earth is near 10^{26} bit/s. This corresponds to (more than) 10^7 J/s, or 10^{26} eV/s (note, the total Sun radiation power is 20 orders larger).

It is well known that some trivial calculations give an insignificant “prior” life appearance probability. For example, in the **[Koonin, 2012]** such the probability is estimated as 10^{-1018}. The famous evolutionist Eugene V. Koonin says that the Antropic Principle and the infinite Multiverse’s concept could explain this. However, I propose another approach: for the life appearance we need practically the same thing that for the periodic table realization. A special *selection rules* together with a regular energy and negaentropy inflow should exist that *interdict* a numerous amount of meaningless combinations. Contrary, these rules *select* the combinations that really exist.

Practically, this idea is not a new one. It is consistent with the important concept of the modern biology which was stated by Berg, Meyen, Lubitshev, Vavilov, and other famous scientists. We do not yet know these rules, however, there exist many indirect proofs in biology (for example, the Vavilov’s homologous series law is similar to the Mendeleev’s periodic table).

The social system evolution

We still do not how Life was appeared on Earth and what namely living (pre)organisms were the first ones. The new types of communities emerge on the several stages of the terrestrial life, and the same general laws act: the regular flow of the negative entropy and new non-linear rules of phase states selection. In fact, Sun continues to send the photons to Earth; the food chains become longer and more complicated, and at each new development level a new ordered communities appear (from cellular colonies up to UN) in which an individual existence turns out to be less preferable than collective one due to the functions differentiation, for example – the specialization of labor between people.

We know the human community evolution history quite better than the terrestrial life history. Finally, complicate communitн of human communities emergeы, not only simplest communities. The links and communications between people and communities develop non-linearly that assures the input resource (energy) use efficiency and depth rise. The structure and evolution dynamics of communities become more and more complicate. During its development the humanity acquires knowledge (as we can see, its *informational resource increases exponentially*) and by such the way controls the more power energy sources. It seems that a next stage is inevitable: we will leave Earth and new cosmic civilizations will appear.

On Nature’s Laws

As we saw, the evolution processes are connected with the nature laws existence, which are investigated by the science. Of course, such the laws really exist (for example, Coulomb’s law or Newton’s ones). However, the question “WHAT are the nature’s law?” seems to be rather philosophical problem that the scientific one. For example, from where does electron knows what the behavior should it demonstrate? Why all the electrons are described by the same laws? How the nature’s laws are incorporated into the Universe?

On the one hand, it is clear that the nature’s laws *are not material*, they are eternal and unchangeable, they have not some spatial or temporal extent (size), they do not correspond with some energy or momentum. So, do we in general can ask such the questions, taking into account that, say, physics describes a material systems only.

On the other hand, our mind may try to answer these questions. We do not state that the following is the *real* case. However, we can *consider* several models that will prompt to us how it *could* be realized in order to deduce several useful conclusions. For example, let us imagine a supercomputer executing many calculations. In such the model the data sets will be an analog of “matter”, while data transformations will correspond to “processes” that consequently form the data set one from another. In our model the “Causality principle” will be held because applying the same procedure (starting the same process) B to the same data set D1 we *always* will get the same data set D2.

In the model the *philosophical* question “*Why*?” can be easily transformed to the *technical* one “*How does it work*?” The answer is simple: the processor (or processor group) of our supercomputer that represents *the meta-reality* relative to “a matter” and “processes” in the internal working space (*memory* in the *meta-reality* language) in perfect case works always by the same manner (relative to every data transformation). The processes in the *reality cannot in principle* have an influence on the processor work in *the meta-reality*. Analogously, a material structures and processes of our Universe cannot (as it seems) have an influence on the nature’s laws that act in it.

Our Universe space and time features also can be deduced from the conditions given in *meta-reality*. For example, the dimension 3 of the space can be connected with the memory organization as 3D vector. The space closity can be provided using cyclic index: x[n+k]=x[k]. The elementary space structure is determined by the memory cells structure, etc.

So, the nature’s laws that do not depend on spatial and temporal relations in our Universe rather can represent the *meta-reality* components and admit some model description in the corresponding frame. The more, the possibility itself to use such the *concepts* in the science (in order to material system behavior describe) points out (as I believe) onto meta-reality existence. Hence, a meta-reality simulation becomes the scientific subject, not exclusively subject of philosophical speculations.

References

[Brillouin, 1961] Brillouin L. American Journal of Physics 29, 318 (1961).
[Egan and Lineweaver, 2009] Ch. Egan and Ch. Lineweaver. A larger estimate of the entropy of the universe. ArXiv:0909.3983v1 [astro-ph.CO] 22 Sep 2009.
[Penrose, 1989] Penrose Roger. The Emperor’s New Mind. Oxford University Press, 1989.
[Smolin, 1994] Lee Smolin. The fate of black hole singularities and the parameters of the standard models of particle physics and cosmology (arXiv:gr-qc/9404011v1)
[Schrödinger, 1955] Schrödinger E. What is Life? The Physical Aspect of the Living Cell.
[Weinberg, 1976] Weinberg S. The First three Minutes. A Modern View of the Origin of the Universe. Basic Books, Inc., Publishers, NewYork, 1976.
[Wikipedia] Wikipedia. Antropic principle. http://en.wikipedia.org/wiki/Anthropic_principle
[Koonin, 2012] A. Ershov. The soup from nail. The conversation with Eugene V. Koonin (in Russian). http://www.lenta.ru/articles/2012/11/30/koonin/
[Shulman, 2011]. Shulman M.H. Time origin and Universe uniform expanding. www.timeorigin21.narod.ru/eng_time/Universe_expansion_eng.pdf

APPENDIX 18. Talk at the Moscow Temporology Seminar

AN ALTERNATIVE COSMOLOGY
(The book's presentation)

December 13, 2011. Moscow State University Seminar on Time

The paper in the magazine "Science and Life" (in Russian), №7, 2011:

www.timeorigin21.narod.ru/rus_time/Lebedev_Shulman.pdf

The book "Alternative Cosmology" (in Russian):

www.timeorigin21.narod.ru/rus_time/Alt_cosmology.pdf

Content:

- ***Why the Universe must be a black hole?***
- ***What the cosmological model follows this fact?***
- ***The cosmological model and the astrophysical data***

The new cosmological approach premises

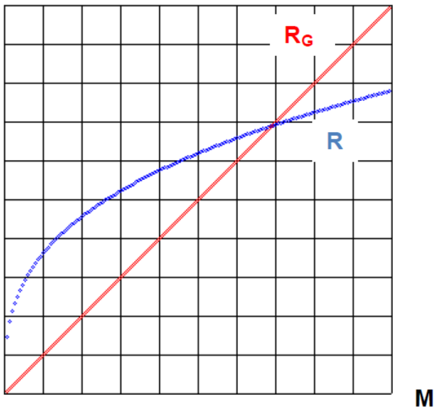
N.A. KOZYREV:
The time course is associated with the Universe energy increasing.

Jh. A. WEELER [1971, by Lee Smolin, 1994]:
It may then be conjectured that each black hole of our universe leads to such a creation of a new universe and that, correspondingly, the big bang in our past is the result of the formation of a black hole in another universe.

A.P. LEVICH:
One can introduce the system's "parametrical" Time as a *linear* measure of its specific resource (the example: the growth rings parametrize a tree evolution).

Universe CAN'T NOT BE a black hole

Let us consider an infinite universe having a *given* (mean) density ρ and infinite mass. Let us select a mental sphere having a small enough radius R. While one increases the sphere radius, its mass M (and its gravitational radius $R_G \sim M$) will increase proportionally to *cube* of the geometrical radius R. In other words, the geometrical radius R is proportional to the cube root from the mass M (and R_G). This dependence non-linearity means that after some critical value (depending on the density ρ) the gravitational radius will be more than the geometrical one (see Fig.), i.e. the sphere has to become a black hole for which a *critical density* $\rho_{cr} \sim (R_G)^{-2}$ is equal to the given density ρ. Thus, our Universe cannot be infinite due the non-evitable collapse.



$$R \approx \sqrt{\frac{3}{8\pi G\rho}}$$

The limitation of the Universe size

Ratio (ρ/ρ_0) for different astrophysical objects in our Universe

Object	Mass M (kg)	Radius R (m)	Gravita-tional radius R_G (m)	$(\rho/\rho_0) = (R_G/R)^3$
EARTH	$6\cdot10^{24}$	$6\cdot10^{6}$	10^{-2}	$\sim 10^{-26}$
SUN	$2\cdot10^{30}$	$7\cdot10^{8}$	$3\cdot10^{3}$	$\sim 10^{-16}$
MILKY WAY	$3\cdot10^{42}$	$\sim 10^{19}$	$\sim10^{15}$	$\sim 10^{-12}$
UNIVERSE	$\sim 10^{53}$	$\sim 10^{26}$	$\sim 10^{26}$	~ 1

Alternative cosmological model

The usual Einstein-Freedmann's equation system may be solved with *new* boundary conditions. (Parametrical) time is suggested as a proportional one to the Universe curvature radius. This automatically leads to the Universe linear expansion law and linear increasing of the Universe mass and matter energy.

Einstein-Friedmann's cosmological equations

$$k(c/R)^2 + (\dot{R}/R)^2 + 2(\ddot{R}/R) = -8\pi GP/c^2$$

$$k(c/R)^2 + (\dot{R}/R)^2 = 8\pi G\rho/3$$

here:

G – the Gravity constant (of Newton),
c – velocity of light,
ρ – density,
P – pressure,
k = 0, 1 or -1 (depending on the curvature sign).

The symbols $\dot{R}$ and $\ddot{R}$ present the first and second variative R on time respectively.

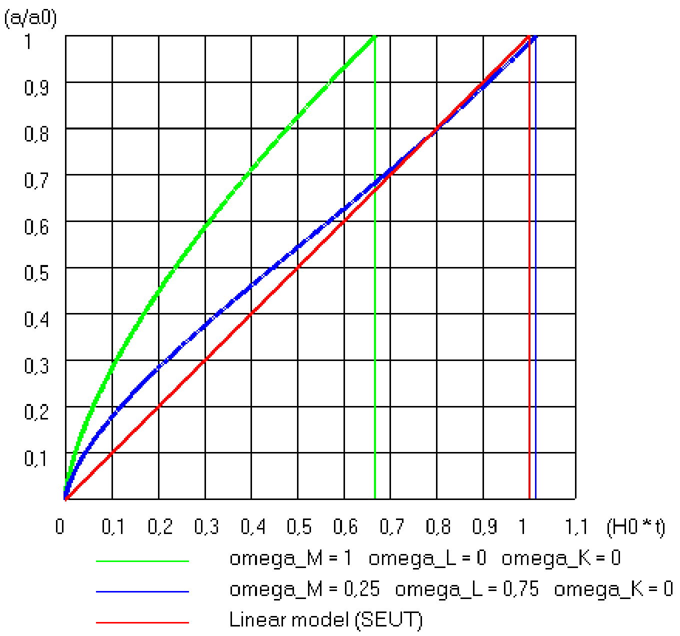
Conventional Boundary Conditions:	New Boundary Conditions:
M = const; P = 0	$\dot{R} = c$ **(const)**

New answers to old questions

The proposed alternative cosmological model gives the very different picture of the Universe evolution than Standard Cosmological Model (SCM). As I checked, the new model describes the correspondance between theory and observed data better than SCM.

- ***The Universe is a black hole and it expanses excluisively due to matter absorption from external world, where the mean density is much more less, and dimension is n = 3 + 1 = 4.***
- ***Any black hole like our Universe presents a closed uniform (n-1)D surface of nD sphere. The sphere centre is not part of the black hole, because of that it does not contain some singularity.***
- ***The mean matter pressure and density in our Universe are the functions of its size, they are not determined by some conflict between an explosion energy and matter gravitational attraction energy, as one thinks after Milne and Eddington.***
- ***The universal attraction forces are due to the negative sign of the matter mean pressure.***
- ***The statement on the exprimental proof of the Universe accelerated expansion is not true, this statement is based on some assumption relative to the non-zero cosmological constant, not purely on the observed data.***

The Universe size evolution with age in SCM and in the new model (SEUT)



The new model and astrophysical data

The following problems are discussed in the book:

- ***The Universe closity***
- ***The cosmological constant is needless. The vacuum problem solution***
- ***The University expansion uniformity, the external cause decisive meaning***
- ***The Universe "horizon" and "flatness" problems***
- ***The CMBR spectrum main peak location***
- ***The existence and explanation of the CMBR spectrum initial peak***
- ***The explanation of the Supernovae low brightness***
- ***The galaxy angular size dependence on Redsshift***
- ***The galaxy amount dependence on Redshift***

The book contains six Appendixes

In the Appendix 1 I analyze the invalid (as I believe) statements of the modern cosmologists.

The Appendix 2 contains a generalization of the black hole entropy famous formula for the case of an arbitrary gravitational source. This allows us to reject the very rough estimation on the base of Beckenstein holographic boundary.

In the Appendix 3 the idea is developped that our Universe evolution is determined by the *open* system laws and its entropy increases (not decreases) with time.

In the Appendix 4 I consider a posiible black hole evolution in a space having dimensionality different from 3.

The appendix 5 explains why one could not travel backwardsin Time.

In the Appendix 6 the photon aging paradox is analyzed.

The answers to several questions posed by A.P. Levich (November 15, 2011)

Any space-time scientific discussion is needless beyond a concrete model	Yes. The proposed model is immediately associated with the concrete time concept
What the time course means? Is this course uniform? How time and space are linked? Time irreversibility.	The time course represents the black hole irreversible expansion. It is uniform by definition. The external space is 4D, and time is the normal to 3D spherical shell.
What is the motion?	There is no any separate movement, this general process is like displacement and stopping of the film.
From where a New origins?	The black hole state changes when (and only when) it absorbs an energy from outside.
Clocks and rulers	Time and space are measured as ratio of the proper elementary particle de Broglie wave parameters to the black hole size.
The space-time wave features	The space-time non-locality and the matter wave features correspond to the black hole shell ondulation.

Author of the photos Youri A. Lebedev