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Cosmology and metabolism

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Nihil est sine ratione
(Nothing is without a reason)

Leibnitz

1. Introduction

What is Time? Why does Universe expand during Time? These two fundamental scientific questions still remain without final answers. The author tries to propose a new understanding of the problem in this paper.

The cosmological concept that is described here seems to be some synthesis of a number of the different thinking directions:

- The prof. Levich's global time conception that associates system variability with a general metabolism process for an arbitrary type system.
- The black holes (BH) theory and its modifications, the BH's cosmological "natural selection".
- The prof. Kozyrev's time representation: time "transforms" into energy.
- Spherical Expanding Universe Theory (SEUT).

So far the links between these directions were not visible. However, as I believe, one can now unify them successfully in an entity. I will try show this below in the paper.

2. Time, variability, and metabolism

Prof. A.P. Levich (the founder and chairman of the Russian Interdisciplinary Temporology Seminar which has been operating at M. V. Lomonosov's Moscow State University since 1984) develops the first direction during some decades. It has a general scientific and philosophical character. Only on 2009th I knew that some basic ideas that I applied to the concrete cosmological purposes he formulated many years ago in the generalized form, at the beginning of 80's (see, for example, **[Levich, 1988, 1995]**). He tried to build the fundamental representation on Time using generalized link between variability and metabolism for arbitrary type systems.

On the one hand, a number of comprehensible ideas were proposed that one can introduce a specific unit of time for any evolving system in order to express its "the system age". For example, in embryology it is a time interval between two sequential cellule divisions, in ecology, genetics, ethnography it is a population lifetime. In geology and history it is the epoch duration. In the gas physics it means the average time interval between particle collisions, in astronomy it may be a period of orbital motion.

On the other hand, Levich proposed for each evolving object to introduce some abstract time as linear measure of its variability, particularly to set it equal to amount of changing elements. Such a time can be non-uniform because its intervals measured by the clocks of two different evolving processes may be not equal. The time measured by a dynamical system clock , as Levich proposes, may be called "parametric" one. This parametric time can be understood as some image of changing objects while one maps a variation process to a linearly ordered metric set.

Levich adds that any changing systems consume some *resource*. This one is specified by a number of numerical parameters, which: 1) have to accompany the system variability; 2) are growing uniformly with system time, and because of that 3) can be used to identify a variation. Thus, the “consumed” resource amount just defines so called system "*metabolic time*". The *external resource* notion leads to irreversible time flow idea and to open world that complexity increases.

3. Black holes and their types

It turns out that the conceptions of metabolism and parametric (metabolic) time can be applied not only to above traditional system, but also to such the astrophysical objects as black hole. All this has for them a non-trivial meaning: black holes (BH) absorb their environment and irreversibly expand just due to it. A BH is born at the matter gravitational collapse, and isn’t causally connected with its environment, because no signal can leave its bound and carry some information about its origin and state.

The most of physicists acknowledged the black hole existence only at the end of 60s. The BH can be described very simply: it is determined (like an elementary particle) only by three (!) freedom degrees – mass, orbital momentum and electrical charge. Karl Schwarzschild was first who described a static non-rotating BH in 1916. Then (in 1916 – 1918) H. Reissner and G. Nordstrom found out the solution that takes into account electrical charge of a non-rotating BH. Later (1963) R. Kerr revealed the solution that takes into account the BH rotation without electrical charge. Finally, in 1965 Kerr and Newman found out the complete solution that takes into account all the three parameters.

Now astrophysicists talk about three basic types of BH: primordial BHs (they were born together with the Universe), stellar mass BHs (tens solar mass) and supermassive BHs in the centers of galaxies having masses equal to millions solar ones.

4. “Natural selection” of BHs

Let us return to the evolution based on metabolism. The BHs appear and evolve consuming matter and energy from their environment. Author of the work **[Smolin, 1994]** recall the Wheeler’s hypothesis which says that each BH is a new expanding universe like our one[1], and any new exemplar may a little differ from its progenitor by a fundamental physical constant values. Smolin means the mass of proton, neutron, electron, and neutrino, and also interaction (weak, strong, electromagnetic) constant values. He starts from several plausible assumptions and shows how the variations of these constants may influence to the number of spiral galaxies “children” (he estimates hundreds BH are born per second in our Universe). It turns out that such small spontaneous variations lead generally to *decreasing* new BH amount. So, some evolution mechanism appears that stabilizes the fundamental physical law parameters in the Universe: it provides the maximum BHs generation. Note, BH’s are the objects having maximal entropy, because of that the maximum of their creation corresponds to a *maximal* rate of the Universe entropy increasing. On the other hand, in my recent publication I showed that BH entropic features (Bekenstein’s generalized second law of thermodynamics and “holographic bound” for the system entropy) represent some extension of a self-gravitating body (**[Shulman, 2010b]**).

[1] I came to this hypothesis independently while tried to base my Time understanding. Only in 2010 I knew that I was not the first.

It is interesting to note that different BHs appear at different time points a rise with different rate. It is hypothetically possible that several ones may increase too fastly and finally absorb all the maternal universe.

5. BH properties: viewpoint of an external observer

The actual cosmology is above all interested in BH description from viewpoint of an *external* observer. In 70s of the previous century the new viewpoint on a BH as a "membrane" was proposed. It states that for any external observer the BH event horizon (or BH boundary surface) seems to be *2D physical membrane* consisting in viscous liquid having several mechanic, electric and thermodynamic properties, as write authors of **[Novikov and Frolov, 2001]**.

A BH event horizon surface may be generally expressed mathematically trough three independent parameters: mass, charge and orbital momentum. Because of that a small increment of *mass* is the sum of such three terms. In this relationship which is analogy of the first thermodynamics law we will especially consider the partial increment

$$\delta M = (\theta/8\pi)\, \delta A,$$

where δA is the event horizon surface area, θ is the surface gravity of BH. This term one can compare with "thermal" term δQ = TδS in the traditional form of the first law, where T is a temperature, δS is a usual object entropy increment[2]. It turns out that the event horizon surface area A of a (non-quantum) BH has the same property as the entropy S: it never decreases during evolution, particularly while a number of BHs merge (Hawking's theorem)[3]. So, the BH evolution is in principle irreversible. Furthermore, the total entropy of the BH and its environment does not decreases too (the Bekenstein's generalized second law of thermodynamics).

On the other hand, the factor before δA proportional to the *surface gravity* plays the role of the effective temperature T. The last one specifies the process of a BH "thermal" radiation due to quantum effects near the event horizon. Such a temperature is *inversely proportional to the BH's mass*, because of that they (like stars and other self gravitating objects) have a *negative* heat capacity.

6. What happens inside black hole?

Let us imagine some observer approaching to a BH using a rocket. A terrestrial observer will believe that the travel time to the BH event horizon of this rocket will be infinitely large. However, the proper (comoving) rocket travel time will be finite, so such an observer will be able to see the BH interior.

The first attempts to describe theoretically what happens inside BH are performed at the end of 70s. Now the common viewpoint of General Relativity is to refuse the membrane model for an *internal* observer (though it is true for an *external* one).

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[2] The Hawking radiation temperature $T_H = (\hbar/2\pi ck)\theta$ is equal to the Unruh temperature $T_U = (\hbar/2\pi ck)a$, where a is an effective acceleration due to a surface gravity field.

[3] Note, the Sun entropy (for example) is 20 orders less than this one of BH with the same mass. "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." (**[Bekenstein, 2003]**).

The General Relativity uses Einstein – Friedman equations that are *continued* to the BH interior. One can find out the different known solutions description in the book **[Kaufman, 1977]**, where the author discusses very exotic aspects of them (intriguing structure, central singularity, connection with another universes, etc.). All these solutions are in principle based on the statement that such a solution in an arbitrary *interior* point *depends on the distance from the center*.

However, several other fundamental problems appear (see **[Novikov and Frolov, 2001]**). Firstly, an initial singularity appears inside BH. Near such a singularity the spacetime curvature approaches to the Plank value, the General Relativity becomes to be not applicable, so a physics discussion could be very speculative. Secondly, several paradoxes appear that are associated with time arrow and causality. For example, the event horizon location and its expansion *before* it meets a falling material shell depends on a *future* event. It seems that the BH membrane lives in “the back time” (from the future to the past). Also, the interior structure of a rotating BH drastically depends on the *future* conditions on the event horizon (for example, it should depend on a future collisions and the Universe fate).

7. New approach to the interior of BH

The above problems, in my opinion, are due to the *invalid* statement that the *internal* solution for BH is the continuation of the *external* one.

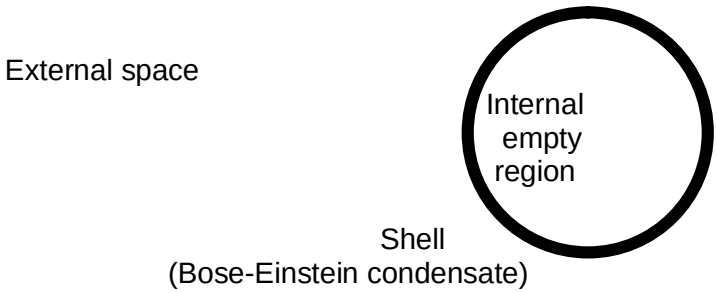


Figure 1. “Gravastar”.

For example, the authors of the paper **[Mazur and Mottola, 2002]** refuse such standard conception of the interior of BH and propose a new solution for the final point of the gravitational collapse. They give the BH model having the usual external space that does not contain a matter. However, the event horizon surface is there replaced by a bounding shell that contains Bose-Einstein condensate and has small but finite thickness (a bit more than Plank length). Finally, the internal region of BH is the empty de Sitter spacetime. The new solution has not a singularity nor an event horizon, and can be specified by the unified global Time. Entropy of the boundary phase corresponds to the standard hydrodynamic entropy, so the information paradox vanishes too. Contrary to BH such a type of collapsing star (the authors call it “gravastar”, see Fig. 1) is thermodynamically stable.

This model is very close to the membrane model for an *external* observer. On the other hand, is is based on the phase transition picture of a usual matter to the Bose-Einstein condensate. However, in this case there is too many of assumptions. Particularly, the shell has a finite thikness.

My own investigation **[Shulman, 2007a]** based on the known General Relativity results revealed very intriguing picture of what happens while a *finite* size BH (not pointed) is appearing. If a body state is far from collapse, then the internal matter pressure is positive and monotonically decreases from the center to the body bound

(Fig. 2). However, when the body state approaches to the collapse, a *pressure breakpoint* appears in its center that cuts out to the bound while the collapse approaching (Fig. 3). On the both sides of the breakpoint this pressure is infinitely large but has the opposite sign.

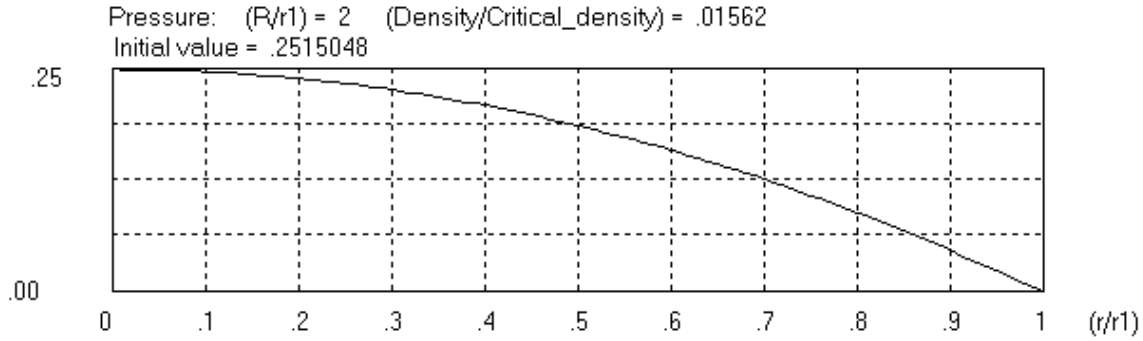


Figure 2. The distribution of the pressure far from the collapse

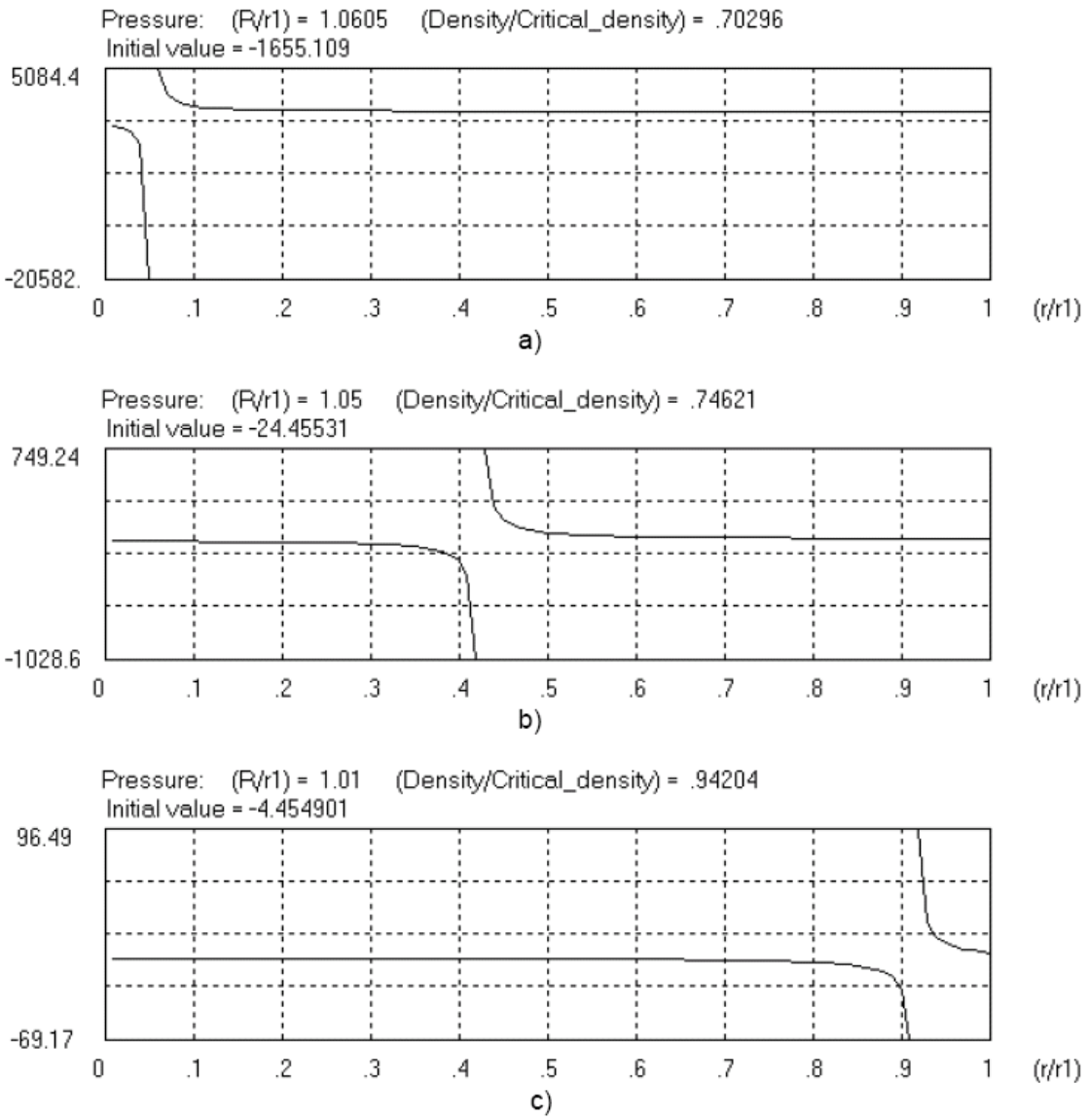


Figure 3. The shifting of the pressure breakpoint to the body bound while the state approaches to the collapse.

This forces me to propose the more radical concept that describes a BH in our Universe and can be used as a base to explain the properties of the Universe itself. Such the concept suggests that a membrane shell *actually appears* on the BH event horizon. However, the change of the space *topology* happens there: the *physical space disappears itself inside the BH*, and a bound (shell) between internal and external regions gets a dimension (n – 1), where n is the usual (external) space dimension. So, in this case the BH has the dimension equal to 2 (not 3).

Accordingly this viewpoint the concept of the BH as a membrane became absolutely exact somewhere. All the mass of BH concentrates uniformly in this 2D region since there is no any difference depending on the distance from the center. It is now clear why the *entropy of the membrane is proportional to its surface area* while the external region entropy is proportional to a volume.

8. Our Universe as the BH in an external super-universe

In my opinion, a BH boundary region dimension decreases by 1 at the collapse, and there is *nothing* inside BH (with any understanding of this word). During the following matter and energy consuming the event horizon surface rises. It rises *faster* than the BH mass, so the surface gravity *decreases*.

As hypothetical 2D observer locating on this surface believes, its 2D universe expands (due to external mass consuming) proportionally to the age. If such the observer is able to compare the universe curvature radius with some standard sample, then in can determine the increment of parametric Time as the quantity that is proportional to this radius increment. Note, that the energy conservation law is not true for this observer in this universe because the total mass and energy are always increasing.

To compare this situation with our Universe one can see that it expands too. In 1993 I reflected the Kozyrev's ideas and came to the understanding of our Universe as a spherical 3D shell of the 4D Euclidean sphere (**[Shulman, 2007b]**). I identified the increasing sphere radius with the universe age that gets the simple and clear meaning of the *parametric time*. The velocity of light in such a model presents an empirical factor of transition from a length among 3D surface to a length perpendicularly that surface. On the other hand, the velocity of light as the maximal propagation speed corresponds to the maximally possible (90?) inclination angle of 4D world line relative to the spatial 3D surface. Such a model can be deduced from the assumption that *our Universe is a 3D BH, i.e. 3D membrane in some 4D environment.*

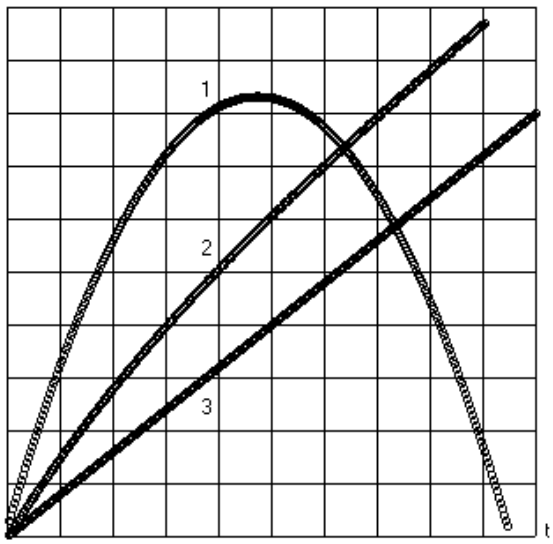
9. Solution of the Standard cosmological model (without Λ)

Let us remember the SCM's solutions that were found in the General Relativity before one could compare them with the observed data, i.e., without some account of the cosmological constant Λ (Fig. 4).

Such the solutions were found using two basic assumptions:

- The pressure was set equal to zero.
- Total mass (and energy) of the Universe is considered as constant.

R(t): Standard cosmological model (without **Λ**)



1 – Density is higher than the critical one
2 – Density is equal to the critical one
3 – Density is lower than the critical one

Figure 4. The Universe evolution models in the General Relativity without account of Λ

10. Geometry of spatial Universe and Time

Note, while approaching to the collapse the geometry inside and on the surface of the collapsing object became the more and more different from this one of Euclidean space, and finally turns out to be spherical and closed. This contradicts to the Standard Cosmology Model (SCM) statement that the spatial geometry of our Universe can be “flat”.

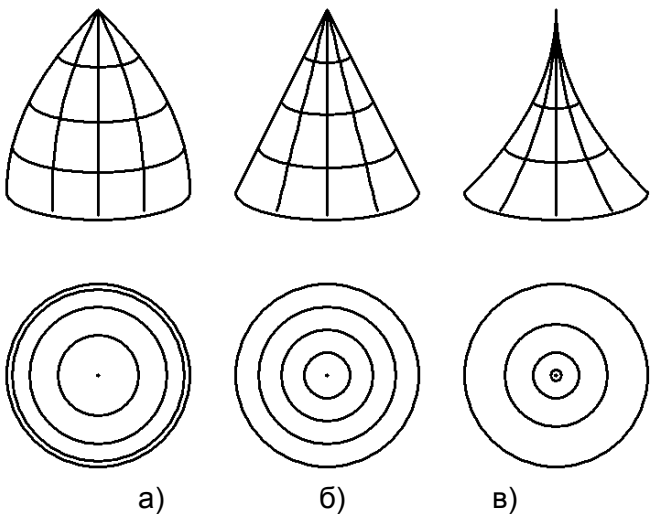


Figure 5.
The geometrical representation of the expanding Universe
(a) the decelerating expansion
(b) the uniform expansion
(c) the accelerating expansion

Contrary, accordingly my hypothesis (the Spherical Expanding Universe Theory – SEUT) the spatial geometry at every time moment is a sphere having a finite radius. Time itself I consider as a parameter that is proportional to the Universe mass and *radius*. So we can consider *locally* the time as the pointer directed normally to the 3D spatial Universe. At every point of the Universe such a direction is unique and generally does not equal to the pointer direction in other spatial points.

Globally we can imagine Time as a generatrix of the 4D cone. In order to explain this let us consider three simplest cosmologic evolution models (see Fig. 5). The top of each cone corresponds to the Big Bang, and bottom corresponds to the *present-day* epoch. Time axis is directed on fig. 5 among the cone generatrix (meridian) from top to bottom, while parallels (that are perpendicularly to meridians) correspond to instant states of the Universe.

So, we must differ the purely spatial geometry type from the time-spatial one. Indeed, at each time moment for all three models in Fig. 5 the Universe state can be (in order to simplify) presented as a *closed* circumference (in practice, finite *closed* 3D world) *independently* on the matter density. However, when we consider a time-spatial cross-section of the cone that contains its generatrix, we may talk about different Universe evolutions models, depending on relation between real matter density and critical one. The corresponding “non-uniformity” of the Universe expansion is shown at the bottom of the Fig. 5.

A fundamental question appears: by what a way each object “knows” about the time currency (as our practical experience confirms)? In my opinion, the quantum mechanics gives the answer. Indeed, every micro-object is specified by a proper de Broglie wave and because of that has “built-in” clock and rod, i.e., a period and length of the wave.

The wave propagation process is a non-local phenomenon and covers all the Universe. When the radius of 4D sphere is changing, the relation between the sphere perimeter length and wavelength is changing too. We can talk about two “quantum numbers”, i.e., about the fraction “Universe age/wave period” and fraction “Universe radius/wavelength”. The striking fact consists in that the first quantum number is particle energy, and second one is its momentum in exact correspondence with physical description. The energy and momentum conservation law became clear: during a small cosmological epoch a Universe size may be considered as constant (error is near 10^{-10} per year), because of that the conservation law (as well as Noter’s theorem presumes) seems to be true.

11. SEUT formalism

The SEUT formalism from mathematical viewpoint is based on the same Einsten-Friedman equations as Standard Cosmological Model (SCM). However, when we *solve* these equations, two essential distinctions appear. We have to refuse two common cosmological assumptions, namely:

- The static matter pressure *is not set* identically to zero, but *is searching* while one solves the equations.
- The conservation law *is not use* as an axiom, because it is not true for the Universe during entire its time existence.

The first who met the pressure problem was Einstein himself: in his model of the Universe he refused (I do not understand, why) the *negative* pressure, though without it the static Universe could not exist at all. He had to invent the “cosmological constant”, which practically presents the same pressure (and corresponding energy). In my

opinion, this one abuses the cosmologists and forces them to search non-effective and fantastic explanations. Indeed, as we have view, just before collapse of a material object the pressure can become negative (and even infinitely high by the magnitude). The more, the negative pressure exactly corresponds to the negative gravitation field energy because it forces the bodies to mutually attract (not to repulse).

What about the energy conservation law note that for the *expanding* Universe that "eats" the energy and matter from environment this law cannot be true, though in our epoch it is correct with the relative error only 10^{-10} per year.

If we refuse these two assumptions, then we should accept something instead of them. The new assumption consists in explicit introduction of the *parametric* time that is strictly equals to the Universe *age* (when the velocity of light is equal to the unit). As we noted, such the time simply parametrizes the Universe state as a BH at a given mass like annual rings parametrize a tree state.

Then we can find out the pressure and energy as functions of the parametric time by solving the Einstein-Friedman equations. Such the solutions (as it should be) determine the (negative) pressure by the function exactly corresponding to the Universe gravitational energy and mass that linearly increase with time.

Such the solution allows us also to explain a number of cosmological features of the observable Universe.

Particularly, we understand clearly the physical meaning of the Big Bang: it represents the start of an object gravitational collapse[4] which is observed "internally", i.e., by an observer from 3D membrane. This membrane age is strictly proportional to its 3D radius. *The mass of each object (like all the Universe mass) increases linearly with time, so Kozyrev's idea that "time transforms to the energy" turns out surprisingly true.*

The Fig. 6 shows (**[Shulman and Raffel, 2008]**) the Universe scale factor dimensionless dependences on its age for different evolution models: red line corresponds to the SEUT, while green line and blue one correspond to two SCM versions. The blue curve corresponds to non-zero cosmological constant, the numerical value is fitted by cosmologists using likelihood criteria for the observed data. Note, the cosmological constant use determines *non-linear* behavior of the blue curve.

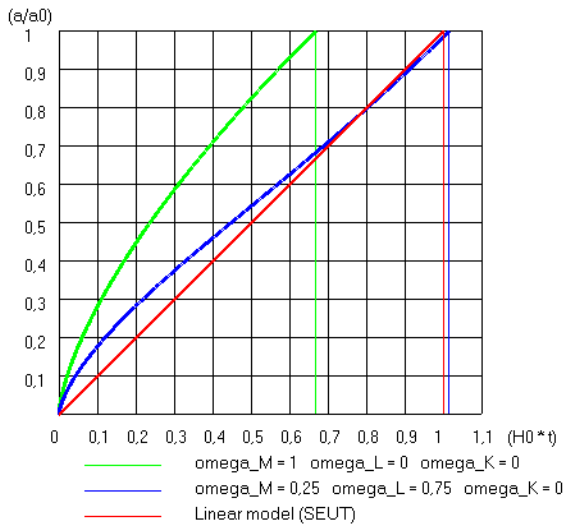


Figure 6. The Universe size changing with age

[4] See the footnote on the page 2: the analogous hypothesis of J. Wheeler is mentioned in the **[Smolin, 1994]**.

12. Argument in favor of SEUT

Now there are several arguments in favor of the SEUT (not SCM). Let us consider them.

Existence of the maximal limit of a speed. In the SEUT a 3D object velocity corresponds to sine of the inclination angle between object world line and the normal to the 3D surface (Fig. 7). As the maximal inclination angle value exists (90°), the maximal speed exists too (angle sine is 1).

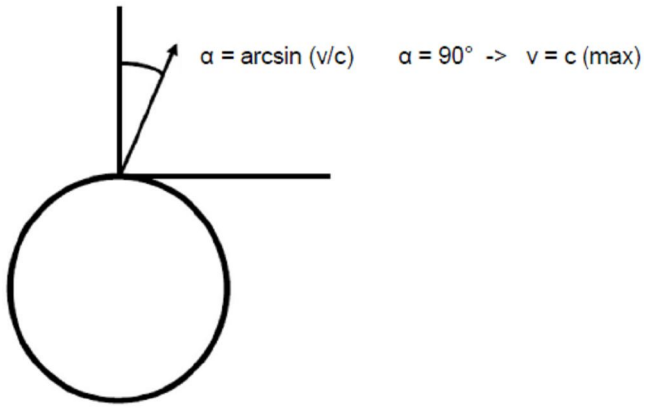


Figure 7. Geomtrical explanation of the maximal speed

Universe as black hole. A connection between the Universe size and its matter density shows that it should be a black holeB. Let us look at the following table (**[Shulman, 2010b]**):

Table 1

The fraction (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	$6\cdot10^{24}$	$6\cdot10^{6}$	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

This hypothesis gives also the clear answer: by what way our Universe was born, or what is the “Big Bang”. It explains the fact of the Universe closure as an entity, its separateness from anything more global. Finally, our hypothesis allows us to study the correctness of the conservation energy law: it shows that now it is correct only with the relative error near 10^{-10} per year.

Problem of the cosmological constant, vacuum energy. In order to obtain the concordance with the observed data, the SCM had to introduce so called cosmological constant in the Einstein-Friedman equations and fit its numerical value. This contradicts to known principle of “Occam's Razor” (do not invent excess essences, leads to the estimation of the vacuum energy 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 or 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.

Cosmic microwave background radiation (CMBR) spectrum analyzis. Above all we discuss the dipole anisotropy of CMBR. This phenomenon has not a common explanation, however, it conflicts with the Relativity's statement on the absence of the preferred frame in the Universe. Our model of time as a direct consequence of the Universe expansion immediately leads to such the "preferred" reference frame. Furthermore, this model predicts that this phenomenon is true for any (not only relic) electromagnetic radiation. For example, one can try to test experimentally that the solar light coming to the Earth at different stages of its annual orbital motion has a different redshift.

There is one more interesting aspect. The both temperature power spectrum and temperature-polarization cross-spectrum have the peak at the multipole number $\ell \approx 5$. The SCM is not able to explain satisfactory this phenomenon. However, my model predicts the existence of just such the peak due to relic photons travelling along the expanding Universe over (360 + 40)° **[Shulman and Raffel, 2008]**.

One believes that the SCM proposes the correct determination of the main peak location of the CMBR spectrum. To base this value SCM the SCM assigns to the Universe geometry the *Euclidean* type. However, in the work **[Shulman, 2010a]** we have show that the correct value of the corresponding angle (0.6°) may be found *independently* on the hypothesis, and SCM's conclusion is only a precondition, not sufficient to get the true result.

Galaxies observation. There is the important cosmological test: the mean galaxy angular size dependence on redshif. Several recently published papers show that the observed data do 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.

So, the coincidence of the real galaxy angular size dependence on redshift with the calculated one can be obtained *only if this size is linearly proportional to the current scale factor*. However, in the SCM the galaxy size is considered as constant (i.e., the Universe expansion is specified only for the largest distance scale, because the galaxies size is governed by the gravitational stability condition), so such the condition cannot be fulfilled. Meanwhile, in the SEUT the galaxy mass (as any other object mass) increases as well as the Universe size, and during this expansion process the gravitational equilibrium does not change (**[Shulman and Raffel, 2010]**)!

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, then 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!

Lower luminosity of Supernovae 1a. In the SCM the fact that at given redshift a distant Supernova seems to be dimmer than one expected is explained using cosmological constant value $\Lambda \approx 0.73$ that leads to the accelerated expansion at present-day epoch. Meanwhile, in the SEUT one does not need use some "free" parameter, it gives immediately the result that (with the observation error) equals to the observed data and the SCM prediction (**[Shulman, 2007d]**), an accelerated expansion is absent by definition, so the present-day epoch does not differ from any other one.

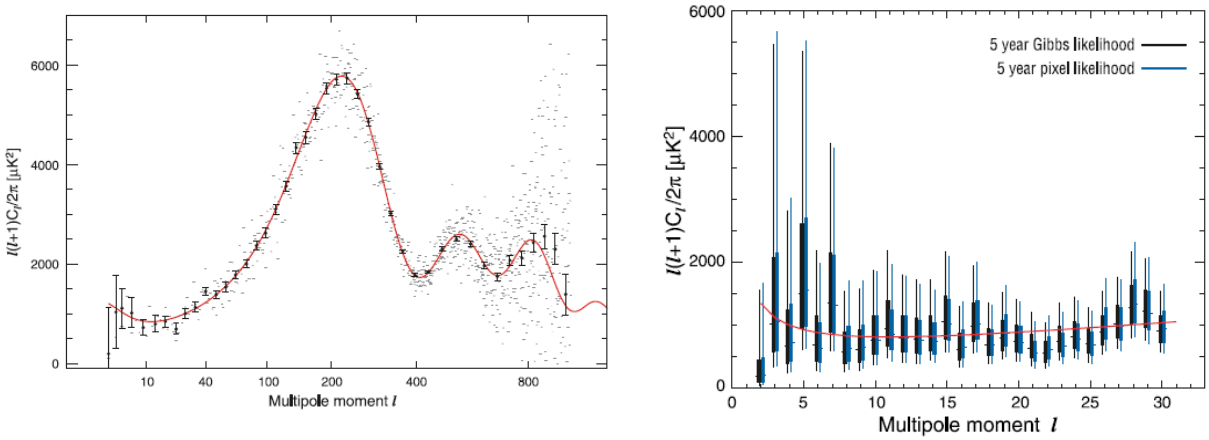


Figure 8.
CMBR temperature fluctuations power spectrum **[Dunkley et al., 2008]**

Preferred reference frame. The Relativity postulates that all the inertial reference frames are equivalent between them. However, a rotating reference frame does not obey this statement (it is confirmed by the well known experiments with gyroscopes). The authors of the recent paper **[Gron and Braeck, 2009]**) base this phenomenon just on the existence of a preferred reference frame connected with the event horizon around our Universe. The more, in the work **[Shulman, 2009d]** I state that actually when one flies around the Universe any difference between a linear motion and orbital one disappears at all. It is not theoretical consideration only: as was noted above, in the work **[Shulman and Raffel, 2008]** we show that such a fly of relic photons around the Universe should lead to a *peak* in the CMBR temperature power spectrum at $\ell \approx 5$ that is actually observed (Fig. 8), but has not any common explanation in the SCM.

So, the SEUT is in accordance with the observed data, although several tests do not allow us to separate it from SCM. However, the SEUT proposes one more test that may be crucial one. We talk about the solar radiation redshift possible difference prediction during the annual orbital Earth motion around the Sun (**[Shulman, 2007c]**).

13. Cosmology and entropy

The present-day cosmology *de-facto* considers the Universe as 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 thermodynamics can do not be satisfied.

My model proposes the new viewpoint on our Universe thermodynamics. In such the model the Universe entropy *decreases*, not increases, since (like working medium of a heat engine) it receives energy from outside at a high temperature and returns it into interior supermassive black holes[5] practically at the zero of the absolute degree. Because of that the cosmological time arrow has the thermodynamic origin and should be considered as primordial relative to biological, thermodynamic, and psychological ones. It is just a reason of a continuous differentiation of the Universe structure and increasing deviation from the equilibrium state during 13.7 billion years of the parametric time **[Shulman, 2009c]**.

[5] The supermassive black holes in the centers of galaxies give a dominating contribution into our Universe entropy (**[Egan and Lineweaver, 2009]**).

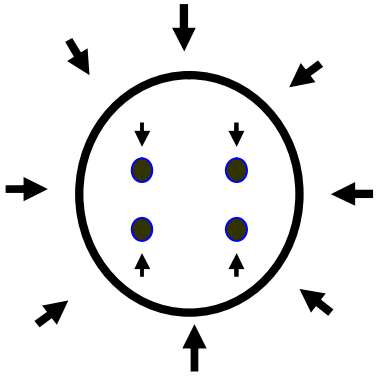


Figure 9.
Universe as a heat engine. Energy flows from Universe environment and into BH interior.

Such the evolution is, of course, due to the fact that BHs (as well as stationary galaxies) are strongly gravitating physical objects and hence have a *negative* heat capacity. In other words, when a star *radiates* its energy, it becomes *hotter*. A BH consumes this energy and becomes *colder*. By this way the temperatures difference and deviation from the equilibrium state in the galaxies increases (does not decreases) during billions years.

Let us consider the question about *white* holes. For an external observer a BH is represented by its boundary event horizon surface (i.e., a 2D membrane). If my hypothesis is true, then the dimension of a BH's environment is by the unit more than the dimension of the BH's interior. In other words, 3D spherical space representing our Universe *in each point contacts with external super-Universe*, i.e., the matter, energy, and information is "created" (coming from outside) in each point of our Universe. Thus, contrary to the case of BH, such the white hole has to be considered as absolutely *global* and *perpetual* object.

References

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

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

[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.

[Gron and Braeck, 2009] Gron O. and Braeck S. A cosmic solution to the twin paradox. arXiv:0909.5364v1 [gr-qc] 29 Sep 2009.

[Kaufman, 1977] William Kaufman. The cosmic frontiers of General Relativity. Little Brown & Co (T), 1977.

[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

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

[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, 2001] Novikov I.D., Frolov V.P. Black Holes in Universe. Usp. Phys. Nauk, vol 171, № 3. March 2001, p.p. 307-324 (in Russian)

[Raffel and Shulman, 2010] G. Raffel, M.H. Shulman. On the galaxy distribution depending on redshift. Available at: http://www.timeorigin21.narod.ru/eng_time/Galaxy_distr_eng.pdf

[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 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, 2007d] 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 and G.Raffel. On the oldest photons phenomenon. Available at: http://www.timeorigin21.narod.ru/eng_time/Oldest_photons_eng.pdf

[Shulman, 2009a] M.H.Shulman. Time and cosmological metabolism. Available at: http://www.timeorigin21.narod.ru/eng_time/Time_and_metabolism_eng.pdf

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

[Shulman, 2009c] M.H.Shulman. Time, Entropy, and Universe. Available at: http://www.timeorigin21.narod.ru/eng_time/Time_and_entropy_eng.pdf

[Shulman, 2009d] M.H.Shulman. Twins paradox and universal reference frame. Available at: http://www.timeorigin21.narod.ru/eng_time/Twins_and_abs_frame_eng.pdf

[Shulman and Raffel, 2010] M.H. Shulman, G. Raffel. On galaxies angular size evolution. Available at: http://www.timeorigin21.narod.ru/eng_time/angle_size_evolution_eng.pdf

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

[Shulman, 2010b] M.H. Shulman. Entropy of a gravitational force source. Available at: http://www.timeorigin21.narod.ru/eng_time/Force_and_entropy_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.

[Weinberg, 1972] Weinberg S., Gravitation and Cosmology: Principles and applications of the General Theory of Relativity, John Wiley and Sons, Inc., 1972.