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Cosmology: a New Approach

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Abstract

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 Noeter'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[1] $\rho = 3c^2\ /\ (4\pi G R^2)$ and the volume $V=2\pi^2 R^3$ 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

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

[1] See for the Section 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. $P = - \rho c^2$).

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.

3. New solutions of the cosmological equations

Using the Section 2 results, we now have not 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[2].

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

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

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:

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

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 $H = 1/t$):

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

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[3].

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.

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

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.

The second problem "is frequently overlooked"[4], 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

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

Universe flatness and horizon problems

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.

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[4] 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"

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.

Universe accelerated expanding problem

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.

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 20th 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".

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