# THE ONLY NON-CONTRADICTORY MODEL OF UNIVERSE

V. Skalský

Faculty of Materials Science and Technology of the Slovak Technical University, 917 24 Trnava, Slovakia, E-mail: skalsky@mtf.stuba.sk

ABSTRACT. The Friedmannian model of the flat expansive non-decelerative isotropic and homogeneous universe with the zero gravitational force state equation is the only model of universe, which does not contradict to the theory of relativity and the quantum mechanics.

**Key words**: Theoretical cosmology, observational cosmology

## 1. Introduction

The mathematical-physical basis of the present relativistic cosmology represent *the Friedmann general equations of isotropic and homogeneous universe dynamics* (Friedmann 1922, 1924). Using *the Robertson-Walker general metrics of isotropic and homogeneous universe* (Robertson, 1935, 1936a, 1936b, Walker 1936) they can be written in the form:

$$\dot{a}^2 = \frac{8\pi G\rho a^2}{3} - kc^2 + \frac{\Lambda a^2 c^2}{3}, \qquad (1a)$$

$$2a\ddot{a} + \dot{a}^2 = -\frac{8\pi G p a^2}{c^2} - kc^2 + \Lambda a^2 c^2, \qquad (1b)$$

$$p = K\varepsilon, \qquad (1c)$$

where $a$ is the gauge factor, $\rho$ is the mass density, $k$ is the curvature index, $\Lambda$ is the cosmological member, $p$ is the pressure, $K$ is the state equation constant and $\varepsilon$ is the energy density.

The Friedmannian equations (1a), (1b) and (1c) – without introducing of any restrictive supplementary assumptions – describe infinite number of *the Friedmannian models of universe.*

Individual Friedmannian models of universe are determined by the Friedmannian equations (1a), (1b) and (1c) with the values: $k = +1, 0, -1$; $\Lambda > 0, = 0, < 0$; and $K > 0, = 0, < 0$.

The Friedmannian equations (1a), (1b) and (1c) represents an application of *the Einstein equations of gravitational field* (Einstein 1915) to the whole isotropic relativistic universe in a Newtonian approximation, under the hypothetical supplementary assumptions, introduced into the relativistic cosmology by Einstein (Einstein 1917), de Sitter (de Sitter 1917) and Friedmann (Friedmann 1922, 1924) and generalised by Friedmann (Friedmann 1922, 1924).

The Friedmannian equation (1a), (1b) and (1c) contain the supplementary assumptions in the mathematically generalised form, therefore, they contains and its factually negation, too. It means that they described the Friedmannian models of universe which are solution of the Einstein equations of gravitation field in the Newtonian approximation with the hypothetical supplementary assumptions and without they, too (i.e. with all possible combinations its non-zero and zero values). Therefore, under assumption that the mathematical-physical description of our observed *expansive and isotropic relativistic Universe* not require an introduction of any next supplementary assumptions, the Friedmannian equations (1a), (1b) and (1c) must immanently contained and the Friedmannian model of universe, which described our observed Universe, too (Skalský 1997).

## 2. The model properties of the expansive and isotropic relativistic Universe

In the observed expansive and isotropic relativistic Universe the gravitation and expansion of matter objects cause the relativistic effects, which for the observers in any co-ordinate systems have different values and in the largest distances, in which the velocity of its expansion approximates to the boundary velocity of signal propagation, they gain extremely values, which approximate to the limit (i.e. zero and infinite) values. Therefore, **the global parameters of the observed expansive and isotropic relativistic Universe (with non-limit values) principally cannot be possibly expressed relativistically!** We can express them only in the non-relativistic approximation, i.e. only using such a theory of gravity in which we abstract from observed relativistic effects.

There exists only one theory of gravitation:

- *The Einstein general theory of relativity,*

  which exactly describes the macro-physical reality, and has only one special partial solution in which we abstract from all relativistic effects:

- *The Newton theory of gravitation (the classical* *mechanics).*

The general theory of relativity is the macro-physical (relativistic) theory of (inertial and non-inertial) co-ordinate systems, which describes the relativistic properties of the physical objects from point of view of any co-ordinate systems; the global relativistic point of view does not exist. Therefore, from point of the general theory of relativity the concepts *whole of universe* and *whole parameters of universe* have not a concrete physical sense!

From point of view of the general theory of relativity about 'the whole of Universe' and about 'the whole parameters of Universe' we can consider only limitly. However, the limit relativistic parameters of the expansive and isotropic relativistic Universe have non-physical (i.e. zero and infinite) values.

We cannot describe the whole of the expansive and isotropic relativistic Universe and its global parameters in a relativistic non-limit way just because the general theory of relativity precisely describes the macro-physical (relativistic) reality.

What it is not possible in the general theory of relativity (because it precisely describes all parts of relativistic reality), becomes trivial in the Newton theory of gravitation. It is because in the Newton theory of gravitation we abstract just from the relativistic effects which in the general theory of relativity such a non-limit description make impossible. Therefore, we can state:

1. **The global parameters of expansive and isotropic relativistic Universe with finite (non-limit) values of the physical quantities can be expressed only in the Newtonian approximation.**

The whole parameters of the expansive and isotropic relativistic Universe in the Newtonian approximation (projection) are equivalent to the parameters of the Newtonian-Euclidean expansive homogeneous matter sphere.

This fact has a significant influence on the model properties of observed expansive and isotropic relativistic Universe, because **the Euclidicity of space in the Newton theory of gravitation principally excludes any consideration on curvature of space in the Newtonian approximation of the expansive and isotropic relativistic Universe!**

The shown facts have these results:

**2a. The expansive and isotropic relativistic Universe in the Newtonian model projection (approximation) is flat (Euclidean), irrespective of actual relativistic matter-space-time properties it has.**

**2b. From the fact 2a reciprocally results that the actual observed expansive and isotropic relativistic Universe principally is not, and cannot be, flat.**

The fact that the global parameters of the expansive and isotropic relativistic Universe can be non-limitly expressed only in the Newtonian model projection, however, it does not mean that the Universe is Newtonian. The observed Universe is relativistic, it means that the Universe in the Newtonian model approximation must consider these relativistic facts:

As a consequence of the finite velocity of signal propagation we can optically observe the Universe up to the beginning of matter era, when – as a result of *"the recombination" of hydrogen atoms* – the matter and the radiation were separated and the Universe became transparent for the photons. Using *the neutrino observing technology* we could see even further, and using *the hypothetical graviton observing technology* we could see up to the cosmological time $t \sim 10^{-43}$ s. Theoretically (using the retrospective extrapolation), we can "reach" even into the beginning of Universe expansive evolution, i.e. up to *the initial limit cosmological singularity.* This means that we are contemporaries of the expansive evolution of Universe at any physically real cosmological times t and theoretically (in the mathematical-physical sense) we are also contemporaries of the initial limit cosmological singularity.

According to Einstein (Einstein 1921), in the finite area no choice of co-ordinates can exclude the gravitational field, however, infinitely small area of space can be considered as flat, in which the laws of the special theory of relativity are valid. Therefore, the theoretical initial limit cosmological singularity with zero dimensions – from the point of view of the general theory of relativity – behaves in two ways:

- As a gravitational object with the limit matter-space-time values in which the motion stopped.
- As an inertial system with the limit matter-space-time values, which expands towards all observers at the boundary velocity of signal propagation.

These facts in the Newtonian model approximation are considered only by the model of Newtonian-Euclidean homogeneous matter sphere, expanding at the constant velocity $v = c$. It means:

3. **The expansive and isotropic relativistic Universe in the Newtonian model approximation is non-decelerative and during the whole expansive evolution it expands at the constant boundary velocity of signal propagation $c$.**

Therefore, for the gauge factor of universe $a$, i.e. for the radius of Euclidean homogeneous matter sphere $r$ and the cosmological time $t$ in the Newtonian model approximation of the expansive and isotropic relativistic Universe are valid the relations (Skalský 1989):

$$a = r = ct. \qquad (2)$$

According to the general theory of relativity, *the gravitational forces* are determined by the sum of the energy density $\varepsilon$ and three-multiple of the pressure $p$.

**4. In the Newtonian model approximation of the expansive and isotropic relativistic Universe (represented by the Newtonian-Euclidean homogeneous matter sphere, expanding at the boundary velocity of signal propagation $c$), the gravitation is not manifested because it is precisely compensated by the expansion.**

Therefore, for the sum of the energy density $\varepsilon$ and three-multiple of the pressure $p$ in the Newtonian model approximation of the expansive and isotropic relativistic Universe is valid the relation (Skalský 1991):

$$\varepsilon + 3p = 0. \qquad (3)$$

The Friedmannian models of the flat expansive universe are determined by the equations (1a), (1b) and (1c) with $k = 0$, $\Lambda = 0$ and $K > 0, = 0, < 0$. These models *de facto* represent the Newtonian-Euclidean expanding homogeneous matter sphere with the radius $r = a$ with the critical mass density $\rho$.

The Newtonian-Euclidean homogeneous matter sphere expanding at the velocity $v = c$ has the radius

$$r = r_g = \frac{2Gm}{c^2}, \qquad (4)$$

where $r_g$ is the Schvarzschild gravitational radius and $m$ is the mass.

From the infinite number of the Friedmannian models of the flat universe – determined by the equations (1a), (1b) and (1c) with $k = 0$, $\Lambda = 0$ and $K > 0$, $= 0$, $< 0$ – only one model can fulfil *the relativistic restrictive assumptions*, expressed by the relations (2), (3) and (4).

The general theory of relativity and *the quantum mechanics* are the complementary theories. The macro-physical relativistic universe is in finite result represented by the micro-physical quantum-mechanical objects (by the particles and the fields) and on the contrary, the quantum-mechanical objects can really exist only in the relativistic macro-world (universe).

It means that the Friedmannian model of universe with assumptions, which result from the general theory of relativity, simultaneously must also fulfil the assumptions, which result from the quantum mechanics (*the quantum theory*).

According to *the Planck quantum hypothesis*, it has a sense to think about the physical parameters of the observed expansive Universe from the moment when its dimensions reach the values, which correspond to the Planck length $l_P = (hG/c^3)^{1/2} = ct_P$, i.e. at the *Planck time* $t_P = (hG/c^5)^{1/2} = l_P/c$ (Planck (1899)).

At present time *the Planck units* are shown with *the Planck (reduced) constant* $= h/2\pi$:
*the Planck length*

$$l_P = \sqrt{\frac{G}{c^3}} = ct_P = 1.616\,05(10) \times 10^{-35}\,\mathrm{m}, \qquad (5)$$

*the Planck time*

$$t_P = \sqrt{\frac{G}{c^5}} = \frac{l_P}{c} = 5.390\,56(34) \times 10^{-44}\,\mathrm{s}. \qquad (6)$$

From definitions of the Planck length (5) and the Planck time (6) it results unambiguously that – according to the Planck quantum theory – the expansive universe could begin its expansive evolution at only one possible velocity $v = c$ and at the cosmological time $t = t_P$ (6) for the gauge factor $a = l_P$ (5) the relations (2) were valid in it. It means that:

From infinity numbers of Friedmannian models of flat universe – determined by the equations (1a), (1b) and (1c) with $k = 0$, $\Lambda = 0$ and $K > 0$, $= 0$, $< 0$ – only one model (i.e. only with one from the values of the state equation constant $K$) can fulfil *the relativistic and quantum-mechanical restrictive assumptions*, expressed by the relations (2) (Skalský 1999).

## 3. The Friedmannian model of the expansive and isotropic relativistic universe

The retrospective extrapolation of the evolution of expansive and isotropic relativistic universe leads to the theoretical initial limit cosmological singularity, therefore, in the Newtonian model approximation of the universe could begin its expansive evolution only at one possible velocity: *the boundary velocity of signal propagation c.*

According to the special theory of relativity, with the boundary velocity of signal propagation c the time-flow will stop, therefore, the expansive and isotropic relativistic universe, which started its expansive evolution at the boundary (limit) velocity (at which the time was stopped), in the Newtonian model approximation (at which the time flow equally with an arbitrary velocity) it must during the whole expansive evolution expand at the constant velocity $v = c$ (Skalský 1989).

In the Newtonian model projection of the expansive and isotropic relativistic universe (i.e. in the Newtonian-Euclidean homogeneous matter sphere, expanding at the constant velocity $v = c$), all parameters are mutually linearly bound, therefore, **the relation between its two arbitrary model parameters can be used as a restrictive assumption for**

**the unambiguously determination of the Friedmannian model universe, which describes our Universe**.

The Friedmannian equations (1a), (1b) and (1c) with $k = 0$ and $\Lambda = 0$ fulfil the relativistic and quantum-mechanical restrictive assumption of the relations (2) (and the relativistic and the quantum-mechanical restrictive assumptions of the relations (3), (4), (5) and (6), too) only with the value of the state equation constant $K = -1/3$, i.e. only with *the zero gravitational force state equation* (Skalský 1991):

$$p = -\frac{1}{3}\varepsilon. \tag{7}$$

Using the Friedmannian equations (1a) and (1b) with $k = 0$ and $\Lambda = 0$, the state equation (7), the Newtonian relations for the Euclidean homogeneous matter sphere and the Hubble relation (Hubble 1929) we can determine the relation between next parameters of the expansive and isotropic relativistic universe, in the Newtonian approximation, i.e. between other parameters of the Friedmannian model of *the* (flat) *expansive non-decelerative* (isotropic and homogeneous) *universe* (ENU) (Skalský 1991, 1993, 1994):

$$a = ct = \frac{c}{H} = \frac{2Gm}{c^2} = \sqrt{\frac{3c^2}{8\pi G\rho}}, \tag{8}$$

where $H$ is the Hubble coefficient ("constant").

The space-time properties of the ENU you can see in the paper: V. Skalský: "The space-time properties of the Universe" in this publication.

## 4. Conclusions

The Friedmannian model of the ENU, determined by the Friedmannian equations (1a), (1b) and (1c) with $k = 0$, $\Lambda = 0$ and $K = -1/3$, is the only model of universe, which does not contradict to: 1. the Einstein general theory of relativity (and its special partial solutions: the Einstein special theory of relativity and the Newton theory of gravity), and 2. the quantum mechanics (Skalský 1999).

### References

De Sitter, W.: 1917, *Proc. Acad. Wetensch. Amsterdam*, **19**, 1217.
Einstein, A.: 1915, *Sitzber. Preuss. Akad. Wiss.* **48**, 844.
Einstein, A.: 1917, *Sitzber. Preuss. Akad. Wiss.* **1**, 142.
Einstein, A.: 1921, *The meaning of relativity*, Princeton, New York.
Friedmann, A.: 1922, *Z. Phys.* **10**, 377.
Friedmann, A.: 1924, *Z. Phys.* **21**, 326.
Hubble, E.: 1929, *Proc. U.S. Nat. Acad. Sci.* **15**, 168.
Planck, M.: 1899, *Sitzber. Preuss. Akad. Wiss.* **26**, 440.
Robertson, H. P.: 1935, *Astrophys. J.* I, **82**, 284.
Robertson, H. P.: 1936a, *Astrophys. J.* II, **83**, 187.
Robertson, H. P.: 1936b, *Astrophys. J.* III, **83**, 257.
Skalský, V.: 1989, *Astrophys. Space Sci.* **158**, 145.
Skalský, V.: 1991, *Astrophys. Space Sci.* **176**, 313. (Corrigendum: 1992, **187**, 163.)
Skalský, V.: 1993, *Astrophys. Space Sci.* **201**, 3. (Corrigendum: 1994, **219**, 303.)
Skalský, V.: 1994, *Astrophys. Space Sci.* **219**, 275.
Skalský, V.: 1997, *DYNAMICS OF THE UNIVERSE in the Consistent and Distinguished Relativistic, Classically-Mechanical and Quantum-Mechanical Analyses*, STU, Bratislava.
Skalský, V.: 1999, http://www.cosmology.sk
Walker, A. G.: 1936, *Proc. Lond. Math. Soc.* **42**, 90.