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*И. С. Нургалиев*¹**КОСМОЛОГИЯ БЕЗ ПРЕДРАССУДКОВ**

Выведено заключение о физически неудовлетворительном (структурно неустойчивом), религиозно обусловленном, чисто математическом характере космологической сингулярности. Показан инерционный характер ускоренного расширения Вселенной, неизбежного в связи с отскоком. Введены понятия материальной точки второго рода и «однородного и изотропного вращения».

Ключевые слова: космология, несингулярная вселенная, завихренность, материальная точка второго типа, религия.

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Introduction

Pre-religious myths and oldest oriental religious sources consider world eternal. Ancient Hindu religious scriptures, for example, describe the universe to be repeatedly originated and destroyed all through eternity by Brahma, the creator, in a never-ending process of finite and transient time cycles called the kalpa.

Younger Abrahamic religions, such as Judaism, Christianity and Islam, cultivated the eschatological conception of the beginning and the end of the universe. The Bible begins with the conception of creation of the universe: «In the beginning God created the heavens and the earth». Many of founding-fathers of the modern science were not only Christian believers but religious thinkers and church figures. Therefore when in the beginning of 20th century scientific theory after apparently unsuccessful static Einstein Universe conceded recognition to singular in the beginning cosmologic model it was almost immediately adopted as world model in harmony with existed religious worldview inherited from founding fathers. The interpretation by the first author of such cosmological solution, Alexander Friedman from Soviet Petrograd, who mentioned parallels between universe and a Phoenix bird from Indian mythology did not impress anybody. Strong religious roots, intellectual and moral leadership of Christianity in European arena, including sciences, consciously or subconsciously, but confidently enough elaborated the concept of beginning delicately substituting term «creation» by religiously neutral term «singular birth». Vatican Conferences of seventies fixed «peaceful co-existence» ceremonially.

Cosmologic model as foremost scientific scenario cannot be left for partisan fantasies because it might challenge trust into scientific method, while its high role is, in contrary, to serve as a sample for quality of other forward engagement disputes such as of global world order, climate change, asteroid danger and others. Almost one-hundred year history of the singular cosmology is good tribute payment by science to the religious faith, to predecessor, but too long saving singular creation as the umbilical cord camouflaged by neutral term my cause intoxication hazard to both organisms. We respect religion not for scientific predictions but for saving humanity from barbarianism.

How come Physics allows such non-scientifically looking model exist as model of reality so long? Well, physicists are also humans with all consequences out of this fact.

1. Getting Rid of Sophism and new material point

Let us start from the scratch. The simplest physical object is material point. Terms such as point mass, and particle are used in English literature more often. By definition they are massive bodies with infinitesimal linear sizes and volume. Material element of mass is treated as a point and, therefore, its deformation and orientation degrees of freedom are ignored. So we see typical sophism. «Let us call it point, as far we call it point let us treat it as a point».

We will call traditional conception of material point material point of the first type to distinguish it from the new concept of the material point of the second type we involve in this paper. New conception is provided by the characteristics of the continuous media in the given point of the space. The main

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differences between two types of the material points are the following: the first type is characterized by finite mass and charge, has not deformational and orientation degrees of freedom; the second type is characterized by density of mass and charge and can be deformed and has orientation in space, just as any element of matter does. Even we call piece of matter a point let as treat it as a piece of matter because it is piece of matter regardless the name.

2. Vorticity is driver of the accelerated expansion

Velocity vector V_α of the material point (further we will mean always one of the second type by default unless other is not specified) is projected onto coordinate space by the tensor of the second rang $H_{\alpha\beta}$

$$V_\alpha = H_{\alpha\beta} R^\beta,$$

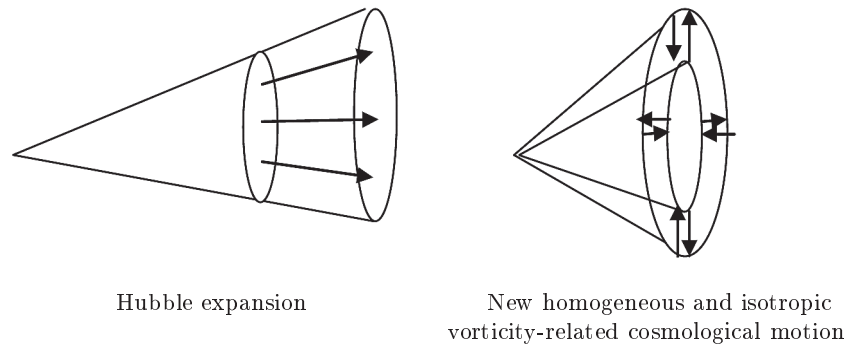
where R^β is radius-vector of the material point (a covariant consideration is presented in pioneer paper [1]). Symmetrical parts of the non-diagonal elements of $H_{\alpha\beta}$ can be eliminated by appropriate choose of the system of coordinates. Therefore for homogeneous and isotropic universe we can simplify $H_{\alpha\beta}$

$$H_{\alpha\beta} = \begin{pmatrix} H & \pm\omega & \pm\omega \\ \mp\omega & H & \pm\omega \\ \mp\omega & \mp\omega & H \end{pmatrix}, \quad (1)$$

where the global average vorticity can be zero ($\langle \omega \rangle = 0, \langle \omega^2 \rangle \neq 0$), though not necessarily.

3. Homogeneous and isotropic rotation

Just as in the case of the skills needed to imagine the homogeneous and isotropic expansion we meet some challenge with the imagining «homogeneous and isotropic rotation». Parenthesis emphasize quite limited appropriateness of the term «rotation», traditionally coming from solid body motion context, to the sort of motion involved here corresponding to vorticity, sort of continuously differential rotational motion of the every material point of the continuous media. The term «the developed turbulence stirring» is also relevant. The rigid body rotation violates isotropy because it involves the specific axis of rotation. This new «rotation» has all directions as a continuum of axes, therefore does not violate isotropy. This is quite analogous to Hubble expansion to imagine.



Picture 1

Picture 1 might serve some didactic help to better imagination and faster visualization of this new cosmological motion accompanying Hubble expansion which, in its turn, also needed some period of time to be adapted in the intuition of the cosmologists first, then of the general audience as the expansion did. Note that expansion, shear and vorticity are three components of the continuous motion with the totally equal rights to exist. Hubble expansion (picture on the left) is a real growth of the cone volume because its height is growing into new volume in the space, while the new cosmological motion is growth (spreading) only of the every given highlighted cone because of the growing its solid angle only within the given limited and existed full angle of 4π . The doubled arrows are mentioning that those material points of the given cone after filling all of 4π radians of space reach starting point again from opposite direction toward starting point and keep moving. This new component of the cosmological motion does

not change the density of the matter in the cone because every given cone, as a local region, has the given height and fulfill the same 4π radians of its previous full solid angle. This motion can be thought as more fundamental than Hubble expansion in this sense because Hubble expansion has limits in its existence (at least the beginning) and therefore transient as a process, while new homogeneous and isotropic vorticity-related motion is able to provide Universe eternity, to counterbalance gravity and to explain acceleration of the expansion. Therefore, it is forth to spend some time to manage to imagine it. Is not this component of cosmological motion unknown wanted fundamental phenomenon which Edwin Hubble was searching for the red shift (transversal in fact) to relate to?

4. Dynamic equations

Researching a role of rotation in cosmology has long history [2-18] (this bibliography is not complete). We will use firsthand Newtonian equations with clear cut didactic motivation – to emphasize that cosmological singularity is consequence of the *too simple model of the flow* and has nothing to do at all with special and general relativism as a cause. The covariant generalization of the result given below for general relativistic description is easy and straightforward.

Standard equations of Newtonian hydrodynamics in standard notations read

$$\begin{aligned} \frac{d\vec{v}}{dt} &= \frac{\partial\vec{v}}{\partial t} + \vec{v}\nabla\vec{v} = -\nabla\varphi + \frac{1}{\rho}\nabla p + \frac{\mu}{\rho}\Delta\vec{v} + \dots, \\ \frac{\partial\rho}{\partial t} + \nabla\rho\vec{v} &= 0, \\ \Delta\varphi &= 4\pi G\rho. \end{aligned} \quad (2)$$

Procedure of separating of diagonal H , trace-free symmetrical σ and anti-symmetrical ω elements of velocity gradient was used by Indian theoretician Amal Kumar Rauchaudhury (1923–2005) [1]. The equation for expansion θ , sum of the diagonal elements of

$$\dot{\theta} + \frac{1}{3}\theta^2 + \sigma^2 - \omega^2 = -4\pi G\rho + \operatorname{div}\left(\frac{1}{\rho}\sum f\right) \quad (3)$$

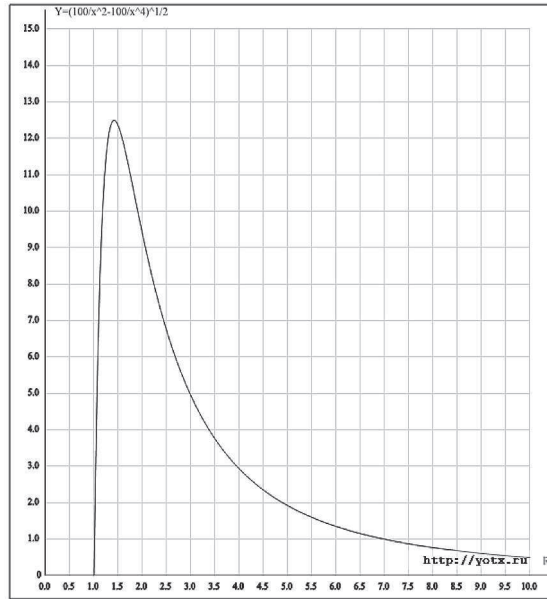
is most instrumental in the analysis of singularities and bears the name of its talented author. In equation (3) we will omit σ , directing coordinate basic axis along the main directions of the deformations. Last term in the RHS is divergence of the sum of all tensions, besides gravity, which is presented as the first term in the RHS. The solution of this equation with only gravity as an interaction, was presented in the publications and reports [19–26] by the author and clearly demonstrated that the long survival of the singularity in the cosmological models are based on the unrealistic supposition of the vanishing vorticity. Presenting exact solutions in terms of Newtonian formalism, which is equivalent, in the presence of pressure – after small modifications, to general relativistic description, – emphasize the real factor of averting singularity, which is *vorticity*. In doing this emphasis stronger and in making driving force for accelerating expansion clearer in this paper we will go even farther. We will ignore not only special and general relativism but Newtonian gravity too! And will come to the conception of the *inertial accelerated expansion*. Inertial accelerated expansion displaces apparent dark energy. Dark energy is possessed by vortex-related degrees of freedom of the second type material points. In other words, it is part of kinetic energy. No mystery.

System (2) gets simplified up to two equations

$$\begin{aligned} \dot{\theta} + \frac{1}{3}\theta^2 - \omega^2 &= 0, \\ \dot{\omega} + \frac{2}{3}\theta\omega &= 0. \end{aligned} \quad (4)$$

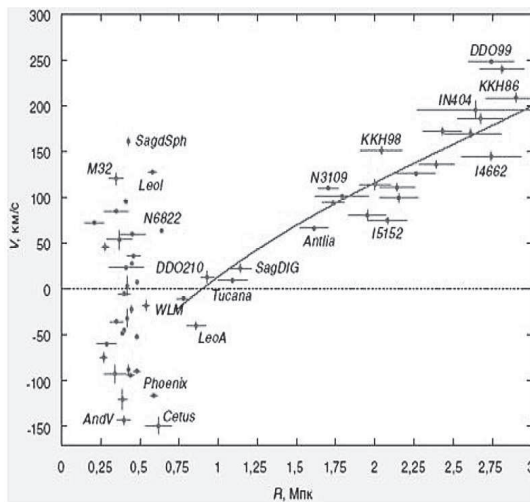
Recalling $\theta = 3H$ the integral of (4) can be presented as

$$H^2 = H_\infty^2 - \frac{3\omega_0^2 R_0^4}{R^4}. \quad (5)$$

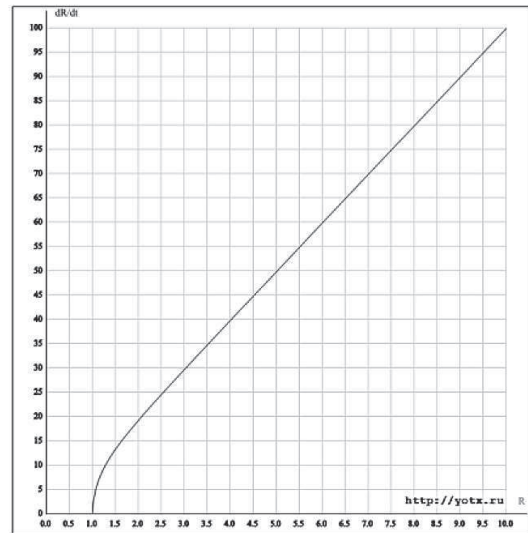


Picture 2.

Qualitative look of function (5) as a curve $y = 100/x^2 - 100/x^4$. The phase point appears from infinite R on the right and bounces back at $y = 0$.



Picture 3. Source <http://elementy.ru/lib/430424>.
I. D. Karachentsev diagram



Picture 4. Qualitative outlook of the velocity function v depending on distance R according to $V = \sqrt{100 - \frac{100}{R^4}}$. Each material point of the second type is surrounded by separatrix spheres eliminating invariant singularity.

Do singular cosmological models have any specific cognitive value while the real universe is not singular as we have seen? Yes they do. Those models are just like extreme car crash test experiments at an automobile plant. Even though real cars will escape such extremely harsh circumstances in reality it is valuable to learn limits of the real characteristics of a car to identify their real weaknesses. Singular cosmologic models along with collapse of the celestial objects serve as a test table and natural collisions plant for new high energy theories such as GUT and quantum gravity.

Historically many authors have solved Einstein equations and Newtonian hydrodynamic equations with rotation in the cosmological context [2–18]. Still existing ambiguities whether a rotation averts the singularities in real cosmology or do not deals mainly with the leaving one direction without rotation, to which the collapse occur even in other directions, with rotations, it is averted. When involved here isotropic rotation is presented in all and each directions this ambiguity disappears [19–26]. Cosmological singularity is gone robustly and can be thought of only as imaginative artificial scenario with nonrealistic space symmetry of cosmologic flow without any chance to be realized in the real Universe. Static Universe is feasible as a model and it is stable because of the stabilizing factor is dynamic vorticity rather than cosmological constant. Static equations

$$\sigma^2 - \omega^2 = -4\pi G\rho$$

in general relativistic consideration of the static averaged universe hold

$$\sigma^2 - \omega^2 = -4\pi G(\rho + 3p).$$

Modification of Hubble law from ideal toy model toward realistic one should be done in accordance with modern observations rather than on the bases of «have to be this way» principle.

Conclusion

Abrahamic religious tradition of neo-creationistic fantasies of singularity in the real Universe after having been nested in scientific cosmology in the 20es and after almost hundred-year survival is displaced by absolutely natural conception of the bounce on the effective centrifugal potential. The dynamics of the Universe appears to be similar to the launching Soviet Sputnik rather than the Newton s apple falling. Two-body and many body tasks are mechanic analogs of the cosmology rather than vertical free fall task. Every Keplerian orbit has apogee with accelerated receding. As Einstein put it, model has to be «as simple as possible, but not simpler».

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Cosmology without Prejudice

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The conclusion about the not robust and religiously biased artificial character of the cosmological singularity is derived. The inertial character of the accelerated expansion of bouncing Universe is illustrated. The conceptions of the material point of the second type and of a «homogeneous and isotropic rotation» are introduced.

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