Rotational Metric of Cosmological Bifurcations and the Role of Constraints in the Formation of the Universe

Baruch Spinoza*: "omnis determinatio est negatio" (each definition is a negation)*

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Abstract

A cosmological model based on the cosmic deceleration parameter q is investigated. The model reveals a bifurcation structure associated with the dark components of the Universe. The model quantitatively reproduces the observed values of the deceleration parameter and proposes a conceptual scheme in which physical constraints, such as the speed of light, act as organizing factors, generating a metric structure and cosmological bifurcations. A concept is proposed in which constraints precede entities, suggesting that the Universe itself emerges from fundamental constraints, rather than vice versa.

Rotational metric of cosmological bifurcations

With angular acceleration α around the main axis, for example, the Z axis, in a dynamic metric in the form of a sphere, a secondary rotation around other orthogonal axes X and Y occurs [10]. In this case, the directions of angular velocities in two opposite hemispheres are oriented towards each other. Thus, when rotating around the Z axis counterclockwise, rotation around the X axis occurs in the hemispheres, where one hemisphere also rotates counterclockwise, and the opposite one – clockwise. A similar picture is true for the Y axis. The absolute values of the angular velocities of these hemispheres are equal and depend on the angular velocity and angular acceleration of rotation around the Z axis:

$$|\omega_x|=|\omega_y|=f(\omega_z) \quad (1)$$

Since the metric is not a rigid body, even with equal angular velocities of the hemispheres, internal dynamics are possible, caused by the gradient of the angular velocity of the metric along the angle θ.

An important digression

Let the angular velocity depend on time and angle, then the angular acceleration α is equal to:

$$\alpha=\frac{d\omega}{dt}=\frac{d\omega}{d\theta}*\frac{d\theta}{dt}=\nabla\omega*\omega$$

Therefore, the angular velocity gradient is equal to

$$\nabla\omega=\frac{d\omega}{d\theta}=\frac{\alpha}{\omega} \quad (2)$$

Let us introduce a dimensionless **coefficient of rotational connectivity of the metric χ**, taking into account its dynamism. Then:

$$\nabla\omega=\frac{\chi\alpha}{\omega} \quad (3)$$

In the absence of initial angular velocity, we can write:

$$\nabla\omega=\frac{\chi\alpha}{\omega}\approx\frac{\chi\alpha}{\alpha t}=\frac{\chi}{t} \quad (4)$$

Knowing the gradient by angle, we can determine the difference in angular velocities at the input and output of the semiperimeter (0 - π) (here the integration is by angle, not by time):

$$\Delta\omega_z = \int_0^{\pi} \nabla \omega\, d(\theta) \approx \frac{\chi \pi}{t} \qquad (5)$$

The cautious assumption is that in the last formula, by analogy with the wave process, we have derived the phase velocity of the rotating metric.

Accordingly, the resulting metric along the x and y axes will be equal to

$$\Delta S_x = -\frac{\sqrt{3}}{2\omega_x} \ln\left(1 - y^2 \omega_x^{\,2}\right) + \frac{\sqrt{3}}{2(\omega_x - \Delta\omega_x)} \ln\left(1 - y^2 (\omega_x - \Delta\omega_x)^2\right)$$

The Importance of Taking into Account the Gradient of Angular Velocity

The derivation of the formula for the Hubble parameter (H) in [10] was carried out without taking the gradient into account – at that time it was not considered at all. Only after the derivation of the gradient presented above does it become clear what significance it may have. In [10, formula (4)], the gradient already appears as one of the key factors in determining H, but then, as noted, no attention was paid to it. It is possible that the appearance of the gradient in the formula is a consequence of the metric under consideration, which assumes coordinate shifts:

$$ds^2 = -c^2 (t)^2 + d\left(x + s_x\right)^2 + d\left(y + s_y\right)^2 + d\left(z + s_z\right)^2 \qquad (6)$$

This approach allows introducing a time asymmetry into the equations of motion, leading to a violation of reversibility and, as a consequence, to the separation of trajectories in the phase space. Using the derivation of (4), it is possible to approximately determine the gradient of the angular velocity in the equation:

$$H=\frac{-2r\frac{dr}{dt}\omega_z^2-2r^2\omega_z\alpha}{\left(1-r^2\omega_z^2\right)\ln\left(1-r^2\omega_z^2\right)}-\frac{\alpha}{\omega_z} \tag{7}$$

Let's break the equation into three parts:

$$H_1=-\frac{2\chi r\frac{dr}{dt}\omega_z^2}{\left(1-r^2\omega_z^2\right)\ln\left(1-r^2\omega_z^2\right)} \tag{8}$$

$$H_2=-\frac{2r^2\omega^2{}_z\frac{\chi}{t}}{\left(1-r^2\omega_z^2\right)\ln\left(1-r^2\omega_z^2\right)} \tag{9}$$

$$H_3\approx-\frac{\chi}{t} \tag{10}$$

As we can see, equations (8) are related to the radial velocity, and equations (9) and (10) reflect the angular velocity gradient.

Determining the acceleration of a system

Despite the replacement of the angular velocity gradient, attempts to accurately solve equations (8–9) have not yielded results, even using symbolic programming methods. In this regard, we will use approximate formulas that are valid for large values of time t:

$$H_1(t)\approx2\chi\frac{\dot{r}}{r} \qquad H_2(t)\approx2\frac{\chi}{t} \qquad H_3\approx-\frac{\chi}{t} \tag{11}$$

Next, we look for the acceleration of the system using the Friedman–Lemaitre–Robertson–Walker formulas:

$$q(\chi) = -1 - \frac{\dot{H}}{H^2} \equiv -\frac{r\ddot{r}}{(\dot{r})^2} \qquad (12)$$

In the model under consideration, r is taken as a scaling factor.

After substituting the parameters H into (12) we have:

$$q_1 = \frac{(1-2\chi)(\dot{r})^2 - r\ddot{r}}{2\chi(\dot{r})^2} = \frac{1+q(\chi)}{2\chi} - 1 \qquad (13)$$

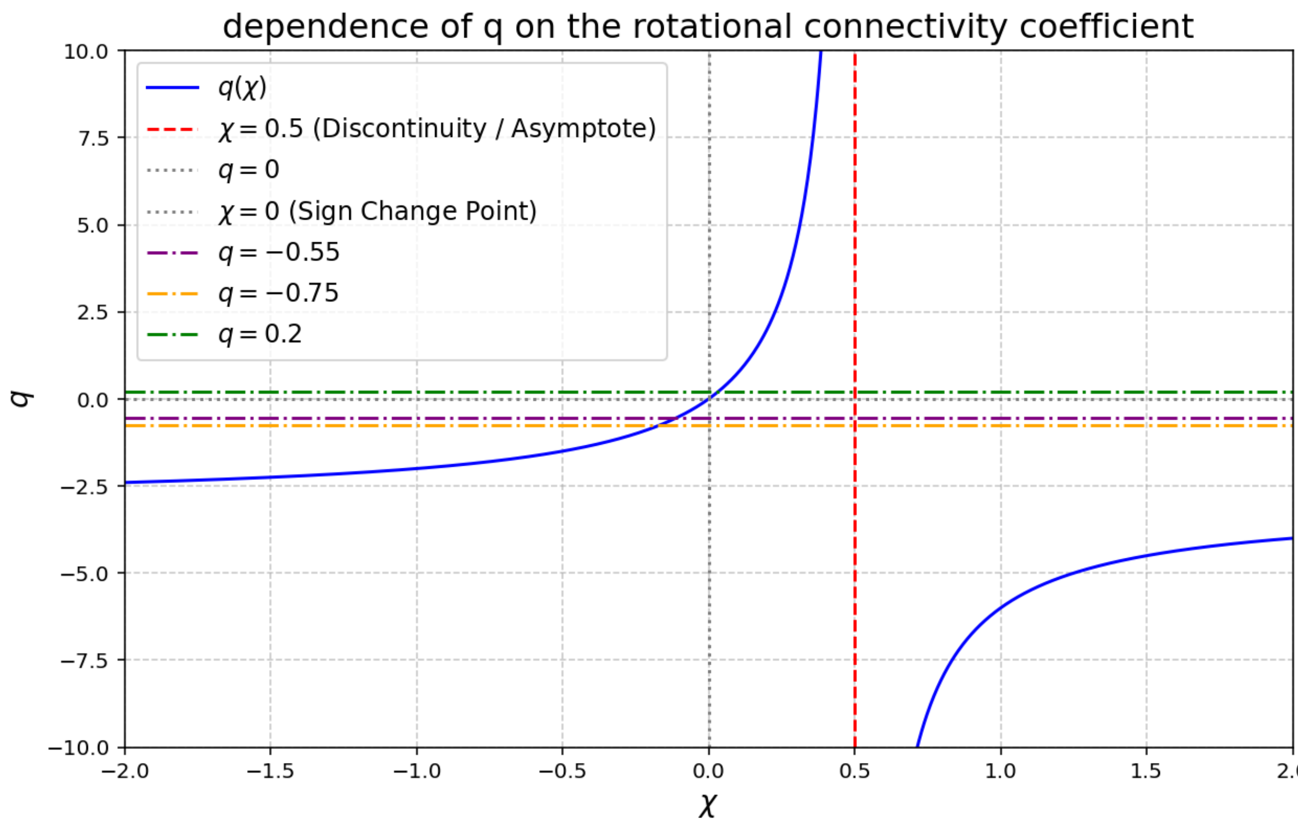
$$q_2 = \frac{1}{(2\chi)} - 1 \qquad (14)$$

$$q_3 = -1 - \frac{1}{\chi} \qquad (15)$$

We find the sum: q (χ) = $q_1 + q_2 + q_3$

From which it immediately follows:

$$q(\chi) = \frac{6\chi}{1-2\chi} \qquad (16)$$



Considering the equation $q(\chi) = 6\chi/(1-2\chi)$ as a parameter of cosmic deceleration and its graph, we can identify several key features associated with the dynamics of the dark components of the Universe.

Singularity structure and phase transitions

The function has a pole at $\chi = 1/2$, which creates a natural boundary in the parameter space. This singularity can be interpreted as a critical point at which a qualitative restructuring of cosmological dynamics occurs. When approaching this value, the deceleration parameter tends to infinity, which physically may correspond to the moment of a radical change in the ratio of dark energy and dark matter.

Bifurcation Analysis

In the region $\chi < 1/2$ the function takes finite values and demonstrates monotonic growth. Here $q(\chi) > 0$ at $\chi > 0$, which corresponds to the slow expansion characteristic of the era of matter dominance. When passing through the critical value $\chi = 1/2$ the system undergoes a bifurcation - a qualitative change in behavior.

Cosmological interpretation

The parameter χ can be considered as a measure of the relative contribution of dark energy. At small χ (in the early Universe), the gravitational slowing down caused by dark matter dominates. As evolution proceeds and the value $\chi = 1/2$ is approached, a transition occurs to a regime in which the antigravitational influence of dark energy becomes critical.

Asymptotic behavior

As $\chi \to 0$: $q(\chi) \to 0$, which corresponds to the boundary between decelerated and accelerated expansion – this is where the modern Universe is in a transitional state between the eras of matter and dark energy dominance.
This model describes the cosmological phase transition using the mathematically rigorous formalism of bifurcation theory, where the singularity at $\chi = 1/2$ plays the role of an organizing center for different modes of cosmic evolution.

According to the Planck 2018 mission, the most accurate values of the cosmological parameters are as follows:
- $\Omega_\Lambda \approx 0.685$ (dark energy)
- $\Omega_m \approx 0.315$ (all matter: baryonic + dark)
- $\Omega_{dm} \approx 0.265$ (dark matter).

Slowdown parameter: $q_0 = \Omega_m/2 - \Omega_\Lambda \approx -0.528$
Solving the equation **$q(\chi) = 6\chi/(1-2\chi) = -0.528$, we get: $\chi \approx -0.107$.**

Physical interpretation of the result:

1. Negative χ: This indicates that the modern Universe is in the accelerated expansion regime, where the antigravitational effect of dark energy prevails over the gravitational braking by matter.
2. Distance from the singularity: The value $\chi = -0.107$ is far enough from the critical point $\chi = 1/2$, which indicates the stability of the current cosmological regime.
3. Bifurcation interpretation: Negative values of χ can be interpreted as a region where the system is in an alternative phase relative to the matter-dominated epoch ($\chi > 0$).

Thus, the $q(\chi)$ model correctly reproduces the observed value of the deceleration parameter, while the parameter $\chi \approx -0.107$ can be interpreted as a measure of the dominance of dark energy in the modern epoch.

Below are the parameters of the slowdown from other sources and the corresponding coefficient of rotational connectivity of the metric χ:

$q = -0.75$, $\chi = -0.1667$ (characteristic of dark energy)

$q = 0.2$, $\chi = + 0.0277$ (characteristic of dark matter)

The role of limitations in the formation of the Universe

The physical model under consideration [7,8,9,10]
is based on:

- **Fundamental limitations (speed of light);**
- **Forced rotational dynamics in a closed "void";**
- **The emergence of a metric structure;**

At the maximum speed in a rotating forcedly closed system, nonlinear effects arise in the metric, which manifest themselves as cosmological phenomena in the form of a bifurcation of dark energy/matter.

In the context of the model: speed limitations → rotational metric → cosmological bifurcations → observable Universe.

A kind of "cosmological constructivism" is obtained - the Universe as a result of self-organization from limitations. Spinoza's phrase can be interpreted as not the essence generating limitations, but on the contrary, limitations creating the essence. The Universe did not create the limitations, but the limitations created the Universe. This is the reason why the fundamental constants are the way they are - not because "it just happened", but because only at these values can the limitations generate a stable cosmological structure like the Universe.
In this paradigm, the anthropic principle sounds a little different: not "the Universe is accidentally suitable for life", but "limitations can only generate a Universe that is capable of self-organization and complexity" - including the emergence of observers. Here we can digress a little and say that the limitations of the speed of light generated not only the Universe, but also intelligence. The phrase from the Book of Genesis: let there be Light (let there be light) sounds amazingly prophetic for modern physics.

The existence of the Universe as an ordered structure is possible only due to the presence of fundamental limitations, primarily the speed of light. These limitations form the boundaries of the realized reality, "cutting" it out of an infinite number of potential states.

In this context, a different view of the traditional interpretation of Mach's principle seems justified, according to which the inertial mass is determined by the global distribution of matter. Perhaps the speed limitation created the prerequisite for the qualitative separation of energy and mass, which form the structured Universe.
The speed of light is the only truly fundamental and universal limitation in the macrocosm. The other "candidates" are either not so universal or are derivative.

Conclusion

The proposed rotational kinematic model demonstrates how a simple analytical expression can describe phase transitions in the evolution of the Universe. Interpreting the singularity as a bifurcation point allows us to relate the observed cosmology to more fundamental constraints.

In this approach, constraints act not as secondary conditions, but as the primary cause of structuring reality - from the metric to the observers themselves. The existence of the Universe as a stable structure in time is possible only due to the presence of fundamental constraints, primarily the speed of light.

It is assumed that future studies will study the connectivity coefficient of the rotational metric, which is apparently not a constant.

Literature

1. Einstein, A. (1911). “Zum Ehrenfesten Paradoxon”. Phys. Zeitschrift 12:509
2.Ø. Grøn, Relativistic description of a rotating disk. Am. J. Phys. 43, 869-976 (1975)
3. M. Born, *Ann. Phys. (Leipzig)* 30, 1 (1909).
4. L. D. Landau and E. M. Lifschitz, *The Classical Theory of Fields,* 3rd. ed. (Pergamon Press, 1971), pp. 233, 234.

5. Jri Bicak and Tomas Ledvinka, Relativistic disks as sources of the Kerr metric
6 .Phys. Rev. Lett. 71, 1669 – Published 13 September, 1993
7. A. Rozenkevich , Rigidly Rotating Disk Dust in the Special Relativity: https://vixra.org/abs/1107.0010, 2011
8. A. Rozenkevich, Relativistic Structure of a Rotating Sphere in a Light Cylinderhttps: https: //vixra.org/abs/2504.0092, 2025

9. A. Rozenkevich, Gradients of the Lorentz Factor in Orthogonal Metrics of the Relativistic Dust Sphere: https://vixra.org/abs/2505.0051,2025

10. A. Rozenkevich, Is it necessary to involve the ether and its analogues to explain dark energy and dark matter?: https://vixra.org/abs/2507.0056

11. Zhen Zhang, Rui Zhang , Rotational Metric: A Solution to Einstein's Clock-Rate Problem and Its Magnetospheric Applications:
https://arxiv.org/abs/2503.20501