Various interpretations of the rotation of the Universe are considered. The absence of the spontaneous symmetry breakdown in the Rosquist model and in the cosmological model filled with a nonlinear spinor field is established.

1. The Interpretation of Rotation

Birch [1], studying the distribution of position angles and polarization of groups of double radio sources, discovered a significant asymmetry in their distribution. This led him to conclude that the Universe is rotating. Recently Kendall and Yong [2] developed a version of noninertial statistical analysis which they applied to this problem. They confirmed the existence of the rotation effect, whatever its nature. During the last years, the interest in studying rotation in cosmology has become even stronger. In [3-8] various interpretations of the rotation of the Universe are examined. As early as in 1965, Stanyukovich [9] obtained a formula for the angular momentum of the observed Universe $I = h x N^3/2, N = 10^{80}$. From a different point of view, Muradyan obtained the formula $I = h (M/m_p)^{3/2}$ for the angular momentum of the Universe. In [3, 5, and 6], this formula was obtained from the point of view of a hierarchical structure of reality. Muradyan's formula can be obtained from the Raychaudhuri equation and the Einstein gravity equations with the ideal fluid energy-momentum tensor.

It is especially interesting to study the role of rotation in cosmology using the modern theory of gravitation. We mention here constructing new cosmological models with rotation [10, 11], studying possible velocities of the Universe's rotation [3, 5, 6], search for effects in a rotating Universe [12, 13], studying torsion in rotating universes [5]. Rotation in cosmology must be divided into rotation of matter and "geometric" rotation. One can speak about "geometric" rotation of a model of the Universe, if the rotating field of the 4-velocity of the fluid (source) is geodesic.

It is even more interesting to study rotation of the early Universe. The study of exact cosmological solutions shows that the angular velocity of rotation of the matter in the early Universe at the Planck time is of the order of $\omega \sim 10^{33} \text{ sec}^{-1}$. It is important to relate this angular velocity to the fact that the velocity of rotation of the matter in today's Universe is very small. To explain the small velocity of rotation of the matter in the Universe, Ellis and Olive [14] use Guta's expanding Universe model. Note that the new cosmological inflationary scenario [15] gives an even greater opportunity to explain the decreasing velocity of rotation.

From our point of view, one can explain the angular velocity of $10^{-13} \text{ rad/yr}$ obtained by Birch via "geometric" rotation, i.e., rotation of the observed Universe itself.

2. Study of Cosmological Models from the Point of View of Spontaneous Symmetry Breakdown

In this section we shall consider the universes of Rosquist [10] (with a rotating ideal fluid), and of Gololobova-Krechet-Lapchinskii [16] with a nonlinear spinor field. Both these models of the Universe are not rotating. In [10], the model of the early Universe is taken to be a homogeneous VI_0 Bianchi-type model with the metric (written with a convenient signature)
ds^2 = df^2 - \frac{1}{2} \left( t^{2q+1/2} \cdot e^{2\varphi} + t^{-2q+1/2} \cdot e^{-2\varphi} \right) \left( dx^1 + dx^2 \right) - \\
- \left( t^{2q+1/2} \cdot e^{2\varphi} - t^{-2q+1/2} \cdot e^{-2\varphi} \right) dx^1 dx^2 - 2mt^{q+1/2} \cdot e^{\varphi} dx^3 \left( dx^1 + dx^2 \right) - \left( 2m^2 + \kappa^2 \right) t^2 dx^3,

For this metric, R = 0. Matter in this model is an ideal fluid (relativistic gas) with the equation of state p = \rho/3. We shall use the Rosquist solution as a model of the early Universe, starting from the moment t = t_0.

Spontaneous breaking of the gauge symmetry in a curved space was studied by a number of authors [17-19]. This effect is present in the open Fridman model. Consider a self-interacting complex scalar field \psi(x) in the Rosquist model with the metric (1), satisfying the equation

\nabla_{\mu} \nabla_{\mu} \psi(x) + (m^2 + R/6) \psi(x) + (\Lambda/3) \psi^* (x) \psi^2 (x) = 0. \hspace{1cm} (2)

We have

R_{\alpha\beta} = \partial_{\mu} \Gamma_{\beta}^{\mu} - \cdots, \hspace{0.5cm} R_{\alpha\mu} = R_{\alpha\beta} \Lambda > 0.

Equation (2) can be obtained as the Euler equation for the Lagrangian density

L = \sqrt{-g} \left[ g^{\mu\nu} \partial_{\mu} \psi \partial_{\nu} \psi - \left( m^2 + R/6 \right) \psi^2 - \left( \Lambda/6 \right) \left( \psi^* \psi \right)^2 \right],

invariant with respect to the gauge transformations

\psi \rightarrow \psi \exp (i\alpha), \hspace{0.5cm} \psi^* \rightarrow \psi^* \exp (-i\alpha).

Let |0> be the Heisenberg vacuum state defined at t = t_0. The spatial homogeneity of the metric under consideration implies that if the vacuum average of \psi does not vanish, it can depend on t:

<0|\psi(t, x^1, x^2, x^3)|0> = <0|\psi(t)|0> = g(t). \hspace{1cm} (3)

Due to the C-invariance of the |0> state, g is real. The nonvanishing of g signifies presence of a spontaneous breakdown of the gauge symmetry. Let us show that in the Rosquist Universe there is no spontaneous symmetry breakdown. Averaging Eq. (2) over |0> and assuming \psi does not vanish, it can depend on t:

<0|\psi^2|0> \approx <0|\psi^*|0>|0|\psi|0|^2 = g^2. \hspace{1cm} (4)

and taking into account Eq. (3), we obtain for the metric (1)

\ddot{g} + \frac{3}{2} \cdot \frac{1}{t} \cdot \dot{g} + m^2 g + (\Lambda/3) \cdot g^3 = 0, \hspace{1cm} (5)

where \dot{g} = dg/dt. In what follows, we assume m = 0. Then Eq. (5) takes the form

\ddot{g} + \frac{3}{2} \cdot \frac{1}{t} \cdot \dot{g} + (\Lambda/3) \cdot g^3 = 0. \hspace{1cm} (6)

Let us perform in Eq. (6) the change of variables g = h/t \cdot f(z), h = \sqrt{3/2}\Lambda, t = \ln t. Then we obtain an autonomous equation

2f'' - 3f' + f |f|^3 = 0, \hspace{1cm} (7)

where f' = df/dt. Let us change the variables in Eq. (7): f = e^{\tau/2} \cdot z, x = 2e^{\tau/2}. We obtain

\ddot{z}(x) - \frac{1}{2} z^3(x) = 0. \hspace{1cm} (8)

The solution (8) can be expressed through the Jacobi elliptic functions

z = - a \cn \left( \frac{a}{V^2} x + b, 1/V^2 \right), \hspace{1cm} (9)

while Eq. (6) has the general solution

\ddot{g}(t) = \frac{-a \cn \left( V^2at^2 + b, 1/\sqrt{2} \right)}{t^{1/2}}, \hspace{1cm} (10)

where a \leq 0, and b are constants.

Since the oscillation period of the nonlinear conservation system described by Eq. (8) is not always the same, but depends on the initial conditions, the periodic motion with the law (9) cannot be considered as stable in the Lyapunov sense. Therefore, the solutions (10)