FRACTAL MODEL OF THE UNIVERSE

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ABSTRACT. In the paper for the first time from the point of view of knots theory it is considered a fractal model of the Universe. In the frames of this model it is shown that to explain its regular evolution it is necessary to adopt a conception that a physical vacuum is crystal-like. As a result it is proposed new approaches to the nature of "dark matter" and a relic radiation origin.

Keywords: Universe, fractal, trefoil, maximon, crystal, vacuum.

1. Introduction

In the given paper it is shown for the first time the model of the which evolution occurs in a regular way. Such a script proposes a crystalline space structure (see, for example, Fomin, 1990). The affirmation that space, time and motion are interconnected could be proved by such a gist: space is created by motion at a time. One of the arguments contributing to the structurization of the space under construction could be the existence of two vacua: μ-vacuum of a "dark matter" and a physical of the surrounding material world. As it is confirmed in (Gliner, 1965), a usual substance turns into μ-vacuum at a negative pressured $p = -\mu c^2$, where μ is a mass density. At the beginning of its inflation the Universe also was in a vacuum state (see, for example, Novikov, 2001; Linde, 1990), with the dimension of $l_p = \sqrt{G\hbar/c^3} \approx 1,6 \cdot 10^{-33} m$ and the density $\rho_p \approx 10^{93} g/cm^3$. Vacuum matter (inflanton) produces gravitational repulsion instead of gravitational attraction which takes place in normal conditions. Just this repulsion according to Gliner's idea gave reason for powerful impulses of giant initial spades generation of the matter inflation. To explain negative pressure this paper suggests the existence of a certain topological structure of the matter in vacuum state. From the heuristic considerations and theoretical calculations by means of knots and braid groups theory application (see, for example, Atya, 1995; Monastyrsky, 1999; Manturov, 2001) it is shown that there is a (a simple knot having a braid of σ_1^3) in the basis of a space structure. By means of the obtained "trefoil equation" and the consideration that the Universe is being constructed in a regular fractal way it is calculated a scale factor behavior coinciding with calculations by means of general relativity. Besides it is considered that "dark matter" has a cubic structure in which knots there are in turn opposite directed right-handed trefoils (further they are associated with electrons). Such a structure will be stable since repulsive forces between right-handed trefoils are compensated by the attractive forces originated in consequence with neighboring one-directed energy flows merging (the density of such vacuum coincides with ρ_p). Further on, since the trefoils (right- and left-handed) are isotopic (converted) in respect to the orientation replacement (see Manturov, 2001), similar structure should be reproduced easily in the process of the "dark matter" crystal rise which is limited by a peculiar fractal surface called a P-surface (see Turbin & Pratsevity, 1992). In the frame of this bifurcate surface in the stage of moderate inflation there occurs worlds with new crystalline vacuum which knots contain in turn one-oriented left- and right-handed trefoils. In this case vacuum structure is determined by means of a balance between attractive forces (left-handed trefoils (positrons) are attracted to right-handed trefoils (electrons)) and repulsive forces originated on account of compensation of opposite-directed energy flows between the neighbouring trefoils (just in this way it could be explained almost a zero density of electron-positron vacuum). It is also supposed that simultaneously with the rise of new vacuum it takes place a throw (channeling) of electrons in its limits from the "dark matter" regions which leads to the origin of relic radiation. This process, evidently, just lead to the moderation of the Universe regular inflation, heating it to the highest temperature. Unlike chaotic script of the Universe inflation (see, for example, Linde, 1990), the given paper deals with a regular fractal evolution of the Universe. Such a regime, first, is attractive due to the reason that now all the regions of a "dark matter" crystal space under inflation are casual-link. Just in the frames of a script of the Universe chaotic inflation of $\sim 10^{87}$ casual-unlink regions, they reveal simultaneous inflation with the possibility of $\sim \exp\left(-10^{90}\right)$ (Linde, 1990). Let's pass

to the analysis of the fractal structure of vacuum and fractal evolution of the Universe.

2. A structure of the physical vacuum and a fractal evolution of the Universe

At it follows from the above mentioned, electrons (right-handed trefoils) and positrons (left-handed trefoils) are structural units (or knots) of the space. We mean here electrons and positrons on Planck distances l_p. Consider that true electron and positron dimensions coincide with l_p and their non-screened masses are equal respectively to $m_p = \sqrt{\hbar c/G} \approx 10^{-5} g$. In other words, non-screened electrons and positrons are elementary particles with a maximum great mass of m_p named by M.A.Markov (1966). In (Markow, 1966) it is marked that gravitation interaction energy of two maximons at distance l_p equals to $W = Gm_p^2/l_p = m_p c^2$, i.e. such interaction resulted in the fact that mass defect coincides with m_p. We may say that there is an exchange between two similar maximons. They all are indistinguishable, i.e. any of them can be considered as a quantum of interaction between two others. Schematically it may be represented as left and right knots in Fig. 1a, b.

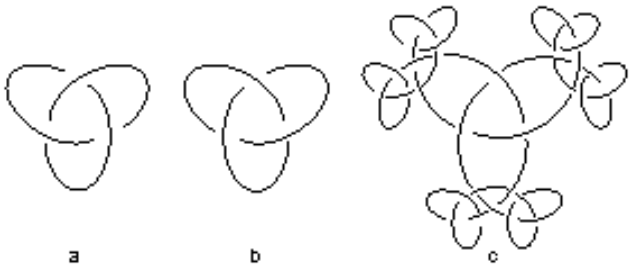

Figure 1: Left (a) and right (b) – handed trefoils, (c) – schematic representation of the process of fractal unravelling of right-handed trefoil

Thus the structure of maximon could be topologically presented as a trefoil each leaf of which is a potential maximon itself with a trefoil structure and so on and so on. Owing to maximon instability which is caused by an exact coincidence of its rest energy with the binding energy, it occurs between maximons almost at the same time (Planck time $t_P = \sqrt{G\hbar/c^5} \approx 0,5 \cdot 10^{-43} s$) non-reversible process of fractal unravelling of the trefoil structure (see Fig. 1c).

Using here a braid group B_2, generated by one oriented element σ_1, corresponding to trivial knot, the braid σ_1^2 corresponds to Hopf link, and the braid σ_1^3 corresponds to the trefoil (Atya, 1995; Monastyrsky, 1999; Manturov, 2001). We compare the equations of $\partial\vec{A}\Big/\partial t = \pm c rot\vec{A}$ with oriented trivial knots. Then Hopf link with a coefficient link +1 is compared with Maxwell equation $\partial\vec{A}_1\Big/\partial t = c \cdot rot\vec{A}_2$ and the link with a coefficient link –1 respectively with Maxwell equation $\partial\vec{A}_2\Big/\partial t = -c \cdot rot\vec{A}_1$. By the analogy to these comparisons, right- and left-handed trefoils correspond to the following systems of equations for vector fields $\vec{A}_i(\vec{r},t)$, $i = 1,2,3$:

$$\partial\vec{A}_1\Big/\partial t = \pm c \cdot rot\vec{A}_2, \partial\vec{A}_2\Big/\partial t = \\ = \pm c \cdot rot\vec{A}_3,\ \partial\vec{A}_3\Big/\partial t = \pm c \cdot rot\vec{A}_1, \qquad (1)$$

Having eliminated in the system of equations (1) the fields $\vec{A}_2$ and $\vec{A}_3$, we get the following vector equation for the field $\vec{A}$:

$$\partial^3\vec{A}\Big/\partial t^3 = -c^3 rot\Delta\vec{A}. \qquad (2)$$

Proceeding to relative units we get the following equation for the function $a(\tau)$:

$$d^3 a(\tau)/d\tau^3 = \kappa a(\tau). \qquad (3)$$

Solving the (3) at initial condition of $a(0) = 1$ and at regularity condition $a(\tau) = a(\tau + n)$, where $n = 0, 1, ...$, we get $\kappa = -8\pi^3 i$ and $a(t) = \exp(i\omega_p t)$, where $\omega_p = 2\pi\sqrt{c^5/G\hbar}$ is a Planck frequency. It is evident from here that the function $m(\tau) = |a(\tau)|^2$ in this case is equal to the unit, i.e. the scale varies.

Now instead of the derivative exponent 3 in the (3) we substitute Hausdorff-Besicovitch fractal dimension $\alpha = \ln 13/\ln 3 \approx 2,335$, characterizing a fractal growth of a crystalline vacuum of the Universe. Expediency of the transition to a fractal geometry is discussed in (Nigmatullin, 1992; Benoit, 2002). As a result we come to the following initial value problem for an arising fractional equation:

$$d^\alpha a(\tau)/d\tau^\alpha = -8\pi^3 i a(\tau) \qquad (4)$$

$$\left.\frac{d^{\alpha-1}a(\tau)}{d^{\alpha-1}a(\tau)}\right|_{\tau=0} = -4\pi^2\ ,\ \left.\frac{d^{\alpha-2}a(\tau)}{d\tau^{\alpha-2}}\right|_{\tau=0} = 2\pi i, \\ \left.\frac{d^{\alpha-3}a(\tau)}{d^{\alpha-3}a(\tau)}\right|_{\tau=0} = 1. \qquad (5)$$

As it follows from (Samko et al., 1987), the solution of the problem (4), (5) is represented in the form $a(\tau) = -4\pi^2\tau^{\alpha-1}E_{\alpha,\alpha}(z) + 2\pi i\tau^{\alpha-2}E_{\alpha,\alpha-1}(z) + \tau^{\alpha-3}E_{\alpha,\alpha-2}(z)$, where $z = -8\pi^3 i\tau^\alpha$, $E_{\alpha,\beta}(z) = \sum_{k=0}^{\infty} z^k/\Gamma(\alpha k + \beta)$ is Mittag-Leffler function. Just the scale factor in this case is a function of a relative time τ and is given by the expression $m(\tau) = \left|d^{\alpha-3}a(\tau)/d\tau^{\alpha-3}\right|^2 = \left|-4\pi^2\tau^2 E_{\alpha,3}(z) + 2\pi i\tau E_{\alpha,2}(z) + E_{\alpha,1}(z)\right|^2$. The

same dependence is represented in (Linde, 1990) but it is obtained by another way, taking into account general relativity.

Such script may take place in the following way. At the beginning the Universe being the right-handed trefoil, starts to reproduce itself spontaneously. Each leaf of the trefoil transforms into three new right-handed trefoils; they occur to be nine. Then each of these nine trefoils again reproduces three new ones; they occur to be 27. This amount of initial space quanta is packed into the initial cube of "dark matter". Further the "dark matter" crystal grows fractally since it is the most optimum way to a spherical form. Further evolution of the Universe leads to the increase of our space volume at the expense of a constant growth of a "dark matter" volume and consequently at the expense of its escape from our matter with the velocity of the light. Imaginary speaking, in the "dark matter" like in a skeleton it occurs an everlasting plaiting of the space (the space is not blowing, it is completing). Simultaneously from all sides it occurs an intervention in our space of isolated right-handed trefoils-maximons (electrons), creating the effect of relic radiation (the oscillations of our space surface layer adjoined to the "dark matter"). From the point of view of the channeling theory as expressed in (Marichev, 1987) this is a radiation of channeling particles, moving towards us at zero velocity. The relic radiation frequency is calculated by the formula $f_{\max} = \omega_P \Big/ \gamma_{\max}^{3/2}$, where $\gamma_{\max} = m_p/m_e$ is a maximum possible Lorentz factor value, m_e is an electron mass.

3. Conclusions

From the above mentioned it is evident that a fractal script of the Universe evolution undergoes following stages: fist vacuum was in a fold stage like a trefoil then it is unravelled in vacuum of a "dark matter" (the period of inflation) and at last in its interior it is originated a vacuum of a compensated electron-positron type. At the same time from the "dark matter" regions as from the source it is injacted from all the sides a noncompensated matter creating the effect of a relic radiation.

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