Cosmic Birefringence from the Scale-Symmetric Theory

Sylwester Kornowski

Abstract: Here we show that the rotation of the CMB linear polarization is the result of the electromagnetic interaction of photons with the rotating electric charge of electrons.

1. Introduction

All indications are that Nature will once again surprise mainstream physicists on important issues.

There is a 68% confidence level that some unidentified field rotates the linear polarization of the cosmic-microwave-background (CMB) photons by the angle $\beta = 0.35 \pm 0.14$ **deg** [1]. Neither the Standard Model (SM) nor General Relativity (GR) predicts such a cosmic birefringence, but neither did they predict dark matter (DM), dark energy (DE), or masses of neutrinos.

Why do leading theories fail on serious issues? We find the answer in the Scale-Symmetric Theory (SST) [2], [3].

The main theories fail because the quark model of hadrons is wrong, because it is not true that spacetime is not granular, because it is not true that pairs of virtual particles can arise and annihilate in empty spacetime, and it is not true that the expansion of the Universe is a direct consequence of inflation.

There is no correct structure of spacetime. In reality, it is two-component and it is the Einstein's spacetime built of the non-rotating-spin-1 neutrino-antineutrino pairs embedded in the superluminal Higgs field, both described in the SST [2].

To explain cosmic birefringence, we need surfaces and loops made of entangled neutrino-antineutrino pairs.

In SST, the electric charges are the tori, which are built of the non-rotating-spin neutrino-antineutrino pairs, with different radii. The proton torus has the equatorial radius equal to $A = 0.6974425$ **fm**, while the electron torus has the equatorial radius equal to $R_e = 3.8660707 \cdot 10^{-13}$ **m** [2]. The ratio of the radii, F, is

$$F = A / R_e = 1 / 554.321 . \qquad (1)$$

On the other hand, the photon and gluon are the rotational energies of single pair or entangled neutrino-antineutrino pairs. The photons in the fields with internal helicity (the nuclear strong field has internal helicity) behave as gluons! Gluons are confined in the strong fields because of their very short time of interactions – it is the period of spinning of the gluon loop that is responsible for the strong interactions inside the hadrons – it has a radius equal to [2]

$$R_{gluon\text{-}loop} = 2\ A / 3\ . \tag{2}$$

Here we show that cosmic birefringence is a result of interactions of the CMB photons with the rotating electric charge of electron on its equator. Notice that the spin speed on the equators of the two tori is $c = 299{,}792{,}458$ **m/s** [2].

2. Calculations

According to SST, the entangled proton-electron pairs appeared because of the beta decays of neutrons [3].

Since the components of the pairs are entangled, the time of the interactions of gluons with nucleons should be the same as of photons with electrons.

The time of the strong interactions of gluons in nucleons, T_{gN}, is equal to the period of spinning of the gluon loops that are responsible for the strong interactions

$$T_{gN} = 2\ \pi\ R_{gluon\text{-}loop} / c = 0.9744876 \cdot 10^{-23}\ \mathbf{s}\ . \tag{3}$$

At this time, the linear polarization of a photon moving in direction perpendicular to the plane of equator of an electron (the photon interacts electromagnetically with the spinning equator of the electric charge), rotates by the angle β_{max}

$$\beta_{max} / 360^{o} = T_{gN}\ c / (2\ \pi\ R_e)\ , \tag{4}$$

so $\beta_{max} = 0.43296$ **deg**.

It is the maximum value for a photon moving along the axis of rotation of the torus of the electron.

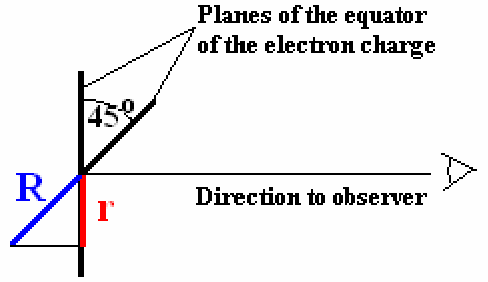

Fig.1
The mean angle of rotation of the CMB linear polarization.

The tori/electric-charges have the internal helicity [2]. Protons and neutrons are internally left-handed, while electrons are right-handed. It causes that, for example, in the beta decays of neutrons, more than a half of the electrons have the linear velocities antiparallel to their spins. Such parity violation leads to the cosmic birefringence. More than a half of the spins of the electrons on the last-scattering spheres in the expanding Universe should be directed towards the interior of such spheres. The angles between the spins and the direction towards the observer may vary from zero degrees to 90 degrees. The mean angle of rotation of the linear polarization, β, is for angle equal to 45 deg. Since the spin speed of the equators is c so the β is directly proportional to radius r (Fig.1). On the other hand, from Fig.1 we have that the mean value is $r_{mean} = R\cos 45^o$, so

$$\beta = \beta_{max} \cos 45^o = 0.306 \textbf{ deg} . \quad (5)$$

This value is consistent with the observational data [1].

3. Misconceptions about the decoupling of photons from baryon matter

It is assumed that the photon decoupling occurred about 380,000 years after the Big Bang, and that the CMB is the electromagnetic-radiation remnant after such decoupling.

It is not true that the photon decoupling took place ~380,000 years after the Big Bang.

The decoupling of photons from matter occurs when they are not forced to penetrate the nuclear strong fields. We should call such a process “the decoupling of photons from the nuclear strong fields”.

Consider a cosmic ball of matter that appeared about 0.5 Gyr after the beginning of the destabilization of the Protoworld [3].

SST shows [3] that from the very beginning, the protogalaxies were clustered in larger structures which partially reflected the present large-scale structure of the Universe. Due to the inflows of dark matter and dark energy into the very early baryonic Universe, there was created the cosmic expanding ball in which the last-scattering spheres composed of the electrons appeared. The radial speeds of the last-scattering spheres varied from zero in the centre of the cosmic ball to almost the c near its surface in such a way that the mean radial speed was $0.6415c$.

The observed small temperature fluctuations in CMB are due to the weak interactions of electrons [3]. Just number density of the electrons, so also intensity of their weak interactions, was higher near the cosmic protostructures. Number of massive galaxy clusters seen in CMB should be higher than we see today because with time some have been scattered by the inflows of dark energy and some of the galaxy clusters have merged.

There were not such eras as recombination or Dark Ages – just matter was ionized more or less all the time from the beginning of the expansion of the baryonic Universe.

Consider a homogeneous ball composed of neutrons, protons and electrons. This is only an approximate picture of the cosmic ball of the need to simplify the calculations. Consider a CMB photon that moves from the surface of the homogeneous ball to its centre – such CMB photon can decouple from the baryon matter when it encounters less than one strong field of single baryon.

Let’s calculate the radius of the Universe when the photons were decoupled and CMB was created.

To make our calculations easier, we assume that all nucleons are on the surface of the ball and that the CMB photon is just above the surface. The range of the strong interactions is $R_{strong} \approx 3$ **fm** [2]. To satisfy the condition that the CMB photon encounters less than one strong field of single baryon, each nucleon should occupy a square with a side greater than $2R_{strong}$. There are $N_{nucleons} \approx 2 \cdot 10^{78}$ of nucleons in the Universe [3], so the area, S_{ball}, of the surface of the ball in the threshold case is

$$S_{ball} = (2\ R_{strong})^2\ N_{nucleons} = 7.2 \cdot 10^{49}\ m^2 . \quad (6)$$

From (6), we can calculate the radius of the homogeneous ball, R_{ball}

$$R_{ball} = [S_{ball} / (4\ \pi)]^{1/2} = 2.4 \cdot 10^{24}\ m = 250 \textbf{ million light-years} . \quad (7)$$

To form such an almost homogeneous ball from the initial state of the early Universe [3], it requires at least time $T_{threshold} = 450$ **million light-years**. It leads to conclusion that the photons were decoupled from matter about 0.5 **Gyr** after the initial destabilization of the Protoworld [3].

4. Summary

We calculated that the cosmic birefringence rotates the CMB linear polarization by an angle $\beta = 0.306$ **deg** which is consistent with the observational data. This rotation is a result of the electromagnetic interaction of photons with the rotating torus/electric-charge of electrons.

Very important in understanding this effect is parity violation which results from the internal helicity of the electron charge.

Moreover, the mathematical description is very simple when we apply the atom-like structure of baryons and structures of spacetime and electrons described in the Scale-Symmetric theory.

References

[1] Yuto Minami and Eiichiro Komatsu (23 November 2020). “New Extraction of the Cosmic Birefringence from the Planck 2018 Polarization Data” Phys. Rev. Lett. **125**, 221301 arXiv:2011.11254v1 [astro-ph.CO] 23 Nov 2020

[2] Sylwester Kornowski (25 September 2020). “Foundations of the Scale-Symmetric Physics (Main Article No 1: Particle Physics)” http://vixra.org/abs/1511.0188

[3] Sylwester Kornowski (14 February 2019). “Foundations of the Scale-Symmetric Physics (Main Article No 2: Cosmology)” http://vixra.org/abs/1511.0223