The E- and B-Modes in the CMB

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Abstract: Here, on base of the lacking part of ultimate theory, i.e. the Everlasting Theory, I described the production of the E- and B-modes in the CMB. The obtained result 0.22 for the ratio of amplitudes of the B-modes to E-modes (i.e. the tensor-to-scalar ratio) for the beginning of expansion of the very early Universe, for multipole moment equal to 384, is close to the central value in the BICEP2 data. The tensor-to-scalar ratio depends on density of the Einstein-spacetime and is higher for higher densities. The calculated energies carried by the Einstein-spacetime components the spreading condensates were built of (such condensates produced the B-modes in the CMB), were in approximation the sixteen powers of ten of GeV.

1. Introduction

On base of the Everlasting Theory [1] there appears following short description of the inflation and the big bangs of universes. In the cited papers, applying 7 parameters and 3 formulae only, I calculated the basic physical constants and a few hundred basic quantities consistent or very close to experimental data.

Inflation started due to collision of very big pieces of space i.e. of the internally structureless and gravitationally massless and internally timeless pieces of the eternal fundamental "substance". The pieces of space cracked onto the smaller pieces of space moving with superluminal speeds, i.e. there appeared the liquid composed of tachyons. Due to the dynamic viscosity of the tachyons, there appeared the two first phase transitions that partially transformed the liquid and next gas composed of the tachyons (it is the Higgs field) into the Einstein spacetime. The components of the Einstein spacetime are moving with the luminal speed and their spin is unitary – they carry gravitational mass about $6.7 \cdot 10^{-67}$ kg. When outside an abstract sphere, the pressure caused by gravitational attraction, acting on the external (in relation to the sphere) Einstein-spacetime components by the Einstein spacetime inside the sphere, exceeded the dynamic pressure in the Einstein spacetime then the inflation had stopped. There appeared the boundary built up from the eternal fundamental "substance". Such boundary is non-transparent for both the Higgs field and the Einstein spacetime. It is the reason that the gravitational constant is invariant. Due to the dynamic viscosity, the Einstein-spacetime components interact with the Higgs field - the Einstein-spacetime components transform the chaotic motions of the tachyons into the divergently moving tachyons what produces the gravitational fields. The calculated radius of the boundary is $2.3 \cdot 10^{30}$ m.

The phase transitions of the Einstein spacetime (due to the possible confinement and entanglement of the Einstein-spacetime components) lead to the particles and new cosmology (there appear the protoworlds - their evolution leads to the dark energy; there appear as well the cosmic loops i.e. the very early universes composed of the rotating protogalaxies built up of the neutron black holes). **It is not true that the big bangs of the cosmic loops (of the very early universes) were during the inflation**.

The ground state of the Einstein spacetime is flat whereas masses produce gradients in the Higgs field.

In the Einstein spacetime can appear flows that, due to the weak interactions of the Einstein-spacetime components, can produce condensates (due to the possible confinement). Condensates are the very unstable objects so they spread very quickly. Condensates are less unstable when the spins of the Einstein-spacetime components are polarized. There are three possibilities:

1.

The spins of the Einstein-spacetime components are aligned and parallel i.e. the condensates look as magnetic domains. When resultant spin of such condensate rotates and the condensate is spreading then it produces the B-modes in the CMB. They are produced by the tensor perturbations (by the spin curls).

2.

The spins of the Einstein-spacetime components are tangent to concentric circles. The resultant spin is equal to zero. When such condensate is spreading then it produces the E-modes in the CMB. They are produced by the scalar perturbations.

3.

The spins of the Einstein-spacetime components are tangent to radial directions (which are divergent). The resultant spin is equal to zero. When such condensate is spreading then it produces the E-modes as well. They are produced by the scalar perturbations. But since distances between the radial directions are changing so such condensate is more unstable.

To create less unstable condensates at higher and higher energies there is needed higher ordering. It leads to conclusion that at very high energies we should observe the B-modes only. **We must emphasize that with increasing energy of the Einstein spacetime, the ratio of the amplitudes of the B-modes to the E-modes increases as well and we can assume that at energy about 10^{16} GeV the condensates produce the B-modes only**. This leads to conclusion that the observed E-modes in the CMB were not produced by spreading condensates. They were produced due to the energy released in the beta decays of the neutrons in the activated protogalaxies (activated by the flows of the dark energy) our cosmic loop (the very early Universe) was built up. At the beginning of expansion of the very early Universe there was the radial polarization of the magnetic axes of the protogalaxies.

We can see that density perturbations (for example, the swelling protogalaxies) produce the E-mode polarization only, whereas the spreading condensates produced in the Einstein spacetime can produce both the E-mode polarization and the B-mode polarization.

Here, I will show that the energy-density fluctuations that can be produced by the condensates that produced the B-modes, is about 10^{16} GeV. This energy does not concern the period of inflation. I calculated for the CMB as well the ratio of the tensor amplitude to the scalar amplitude i.e. the tensor-to-scalar ratio.

The observed differences in temperature in the CMB (about one part in 10^5), is close to the coupling constant for the electron-proton interactions so such fluctuations appeared due to the activation of the protogalaxies by the inflowing dark energy.

In the Einstein spacetime are possible gravitational flows (not gravitational waves) which produce the fluctuations, condensates and particles.

The Everlasting Theory I described in the book and 23 papers [1]. This theory is based on two fundamental axioms. There are the phase transitions of the fundamental spacetime composed of the superluminal and gravitationally massless pieces of space (the tachyons). It is the modified Higgs field that I refer to as well as the Newtonian spacetime. The phase transitions follow from the saturated interactions of the tachyons and lead to the superluminal binary systems of closed strings (entanglons) responsible for the quantum entanglement, lead to the binary systems of neutrinos i.e. to the Einstein-spacetime components, to the cores of baryons and to the cosmic objects/protoworlds that appeared after the era of inflation but before the observed expansion of our Universe. Second axiom follows from the symmetrical decays of bosons that appear on the surface of the core of baryons. It leads to the Titius-Bode law for the strong interactions i.e. to the atom-like structure of baryons. The two first phase transitions are associated with the Higgs mechanism that leads from the modified non-gravitational Higgs field to the Principle of Equivalence and to the initial conditions applied in the General Theory of Relativity. The three first phase transitions concern the particle physics whereas the structure and evolution of the most sophisticated spinor, i.e. the cosmic object/Protoworld, defined by the four phase transitions, leads to the new cosmology. The foundations of the new cosmology we can find here [2].

The Everlasting Theory leads to following conclusions.

1.

There was inflation which quantized gravity i.e. there appeared the paired smallest gravitational masses which are the Einstein-spacetime components – each component has gravitational mass in approximation $6.7 \cdot 10^{-67}$ kg [2]. The Einstein-spacetime components are non-relativistic [2].

2.

In the Einstein spacetime were and are produced flows (they are not the gravitational waves). When distance between the Einstein-spacetime components decreases in approximation 0.8 per mille then, due to the weak interactions of the components, there appear the condensates in the Einstein spacetime [2]. Such condensates are in centers of charged leptons and all baryons. Since the spins of the Einstein-spacetime components can rotate and since the components are non-relativistic so gravitational mass of the condensates can be invariant whereas their energy can vary.

3.

Due to the flows in the Einstein spacetime, there are the changes in its mass density but they are very, very low i.e. of order 10^{-50}, but such changes can produce the protoworlds and cosmic loops (the very early universes) built up of the protogalaxies composed of the neutron black holes [2]. Our cosmic loop was left-handed so today the big spiral galaxies should be polarized in specific way i.e. they all should whirl in the same direction in relation to the senses of their magnetic axes [2].

4.

The inflows of the dark energy activated the protogalaxies [2].

5.

The activated protogalaxies should produce the observed E-modes in the CMB.

6.

The electrons that appeared in the beta decays, produced condensates which masses were the same as the condensate in centre of electron (0.2552 MeV [2]) whereas due to rotational energies of the Einstein-spacetime components the energies of such condensates can be tremendous. Such condensates should produce the B-modes in the CMB.

7.

There are not in existence the gravitational waves but there are flows and were the protuberances in the Einstein spacetime caused by the inflows of the dark energy [2].

On the other hand, here [3] is the conclusion that the BICEP2 collaboration found indirect sign of gravitational waves. They claim that the observed B-modes (curls) in the CMB are due to rippling gravitational waves. They rejected some other alternative explanations as, for example, polarization caused by more distant galaxies. But the explanation has one very important weak point. Just, due to the mainstream theories of inflation, the B-modes should be much weaker than the observed. It leads to conclusions that probably the mainstream description of creation of our Cosmos is incorrect.

2. Calculations

On base of the Everlasting Theory, we can calculate the rotational energies of the Einstein-spacetime components in the period of the B-modes production at beginning of the expansion of the very early Universe (existence of the B-modes suggests that there were the gravitational flows in spacetime but it is not direct evidence that gravitational waves exist).

From the theory of baryons [2] follows that range of bosons of energy about $E_{boson} = 0.7503$ GeV is about $B = 0.5018 \cdot 10^{-15}$ m. On the other hand, during the activation of the protogalaxies by the inflows of the dark energy, instead the gravitational interactions between the Einstein-spacetime components there dominated the weak interactions. According to the Everlasting Theory [2], range of the weak interactions of the Einstein-spacetime components is about $R_{weak} = 3.895 \cdot 10^{-32}$ m. Since energy is inversely proportional to range so energy E of the Einstein-spacetime components, during the period of the B-modes production, was

$$E = E_{boson} B / R_{weak} = 0.967 \cdot 10^{16} \text{ GeV}. \quad (1)$$

This energy is characteristic for the beginning of the expansion of the very early Universe.

The Everlasting Theory [2] shows that due to the Thomson polarization theory, the CMB should be polarized with amplitude of a few μK with upper limit for E-mode 6.1 μK. This E-mode is associated with energies produced in the beta decays of neutrons [2]. The CMB polarization was highest when the produced velocity gradient was at its highest (i.e. the neutron black holes swelled due the inflows of the dark energy). The velocity gradient, i.e. the polarization spectrum, is out of phase with the density spectrum, i.e. with temperature anisotropy.

The electrons that appeared due to the beta decays, at very high energy produced condensates composed of the Einstein-spacetime components. Their gravitational mass Δm is the same as the condensate in centres of the electrons i.e. is equal to the half of the mass of bare electron $\Delta m = m_{bare(electron)}/2 = 0.2552$ MeV [2]. Such condensates are less unstable when the spins of the Einstein-spacetime components are polarized in manner similar to magnetic domains. At very high densities, the resultant spins of the condensates rotated. The orientation of the resultant spins of the condensates can be arbitrary. Such curling and spreading condensates produced the B-modes.

For multipole moment l = 384, the calculated temperature fluctuation which results from the energy released in the beta decays, is for the E-modes 6.1 μK. This temperature fluctuation is associated with the energy $\Delta E = m_{neutron} - m_{proton} - m_{electron} \approx 0.78$ MeV released by decaying neutrons in the activated protogalaxies [2].

To calculate a mean value assume that there are the orthogonal reference systems associated with the condensates. Assume that they are oriented in such a way that the x-axes overlap with the direction of observation. For resultant spin of a condensate overlapping with the x-axes, we obtain energy associated with the B-modes equal to zero (two possibilities: parallel and antiparallel orientation of the resultant spin) whereas for overlapping with the y- and z-axes, we obtain the Δm (four possibilities). We can see that the arithmetic mean energy is equal to 2/3 of the Δm. Calculate for the $\ell = 384$ the ratio r of amplitudes of the B-modes to the E-modes

$$r = 2\Delta m / (3\Delta E) \approx 0.22. \quad (2)$$

This result is very close to the central value in the BICEP data [3].

When rotational energy of a spreading condensate is equal to zero then it does not produce the B-modes so r = 0. In the regions with the higher densities of the Einstein spacetime (it was during the inflows of the dark energy into the very early Universe) there dominated the spin polarization of the condensates characteristic for the magnetized ferromagnetic substances (it was due to the strong short-range entanglement of the Einstein-spacetime components [2]; all spins of the components are aligned and parallel) i.e. the spreading and curling condensates produced the B-modes. But there can be spreading condensates in which the spins are tangent to the radial directions or in which the spins are tangent to concentric circles with increasing radius. Then resultant spin of spreading condensate is equal to zero so it behaves as scalar which produces the E-modes. There should be some density at which energies of the E- and B-modes associated with spreading condensates are the same. Calculate the ratio r for such spreading region at the beginning of expansion of the very early Universe

$$r_h = (\Delta m / 3) / (\Delta E + \Delta m / 3) \approx 0.10. \quad (3)$$

3. Summary

Here, on base of the lacking part of ultimate theory, i.e. the Everlasting Theory, I described the production of the E- and B-modes in the CMB. The obtained result 0.22 for the ratio of amplitudes of the B-modes to E-modes (i.e. the tensor-to-scalar ratio) for the beginning of expansion of the very early Universe, for multipole moment equal to 384, is close to the central value in the BICEP2 data. The tensor-to-scalar ratio depends on density of the Einstein-spacetime and is higher for higher densities. The calculated energies carried by the Einstein-spacetime components the spreading condensates were built of (such condensates produced the B-modes in the CMB), were in approximation the sixteen powers of ten of GeV.

The E- and B-modes production is not directly associated with the period of inflation. It is associated with the phenomena at the beginning of expansion of the very early Universe, respectively, with the swelling protogalaxies composed of the neutron black holes (it was caused by inflows of the dark energy) and with the spreading curling condensates in which the spins of the Einstein-spacetime components were aligned and parallel. The condensates behaved as curling magnetized ferromagnetic.

There are not in existence the gravitational waves but there were the protuberances in the Einstein spacetime caused by the flows of the dark energy, and there were and are the flows of the Einstein-spacetime components.

References

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