The Positron Fraction in Primary Cosmic Rays and New Cosmological Problems

Sylwester Kornowski

Abstract: Here, within the Scale-Symmetric Theory (S-ST), I calculated the positron fraction in primary cosmic rays as a function of energy and described positron flux. Obtained results are consistent with the data from the Alpha Magnetic Spectrometer (AMS) on the International Space Station (ISS). These data lead to the internal structure of the core of baryons and to phenomena characteristic for regions in the Universe filled with baryonic plasma described within S-ST. Here, as well within S-ST, I described new cosmological problems which lead to new cosmology. They are as follows. There are not in existence the B-modes associated with gravitational waves - it leads to conclusion that there was a separation in time of the inflation and the big bang of the Universe or that gravitational waves do not exist (S-ST shows that both conclusions are correct). In the very distant Universe there is too small number of dwarf galaxies. In the very distant Universe there are the massive galaxies which do not significantly evolve so a time for their formation was too short. In the very distant Universe there are too many barred galaxies - it is inconsistent with simulations grounded on the Cosmological Standard Model (CSM). There is a substantial asymmetry in the CMB signal observed in the two opposite hemispheres of the sky. These new problems suggest that CSM starts from wrong initial conditions.

1. Introduction

Within the Standard Model (SM), since 1964, we cannot calculate the exact mass, spin and muon radius of proton. It suggests that the three-valence-quarks model cannot be realized by Nature at low energy. Just at low scales the perturbation theory breaks down so we do not understand the dynamics that lead to confinement and entanglement. Non-perturbative methods are required and the non-perturbative Scale-Symmetric Theory (S-ST) provides such methods. Within S-ST we calculated hundreds of results and they are consistent with experimental data. Here, [2], among many calculated results, are the rigorous mass and spin of proton whereas in paper [3] are calculated the exact electron and muon radii of proton.

The S-ST shows that in centre of the baryons there is the core composed of torus and condensate. The Einstein spacetime associated with SM is grainy and consists of the neutrino-antineutrino pairs. Mass of each pair is very small (about $6.7 \cdot 10^{-67}$ kg) and the total weak charge is equal to zero – it causes that detection of the Einstein-spacetime components is much difficult than neutrinos. The internal structure of the Einstein-spacetime components causes that they can be confined or/and entangled. The torus is built up of entangled and confined Einstein-spacetime components whereas the condensate consists of confined ones only. Mass of the charged core is $H^+ = 727.44$ MeV ([2], formula (34)) whereas of the neutral one is $H^o = 724.78$ MeV ([2], formula (35)).

In baryonic matter (protons and neutrons) the core cannot be charged negatively [2]. It causes that there appears the positron-electron asymmetry. The positron-electron pairs produced inside the positively charged core of baryons appear as pairs composed of real positron, e^+, and virtual electron, $(e^-)^*$.

The calculated fine-structure constant is $\alpha_{EM} = 1/137.036$ ([2], formula (21)). The calculated coupling constant for weak interactions of proton and electron is $\alpha'_{W(e-p)} = 1.11943581 \cdot 10^{-5}$ ([2], formula (58)). The calculated weak binding energy of the torus with the condensate is $E_W = 14.980$ MeV ([2], see the explanation below formula (51)). The calculated electromagnetic binding energy of the torus and an electron placed on the circular axis of the torus is $E_{EM} = 3.097$ MeV ([2], see the discussion above Table 1; this energy leads to the Higgs boson with a mass of 125 GeV [4]). The calculated mass of the condensate is $Y = 424.124$ MeV ([2], see the explanation below formula (49)). The calculated mass of muon is $m_{muon} = 105.656314$ MeV ([2], formula (27) and explanation below this formula). The calculated lower limit for the mass of a loop produced by the core of baryons is $m_{LL} = 67.54441$ MeV ([2], formula (8)). The calculated mass for the upper limit of a loop produced by the core of baryons is $m_{UL} = 727.44$ MeV ([2], Table 1). The calculated mass of electron is $m_{electron} = 0.5109989$ MeV ([2], formulae (18) and (69)). The calculated mass of charged pion is $m_{pion(+,-)} = 139.57041$ MeV ([2], see explanation below formula (23)). The calculated mass of the boson characteristic for baryonic plasma $m_{boson} \approx 283$ MeV ([2], see explanation above formula (162)). The calculated mass of charged pion is $m_{pion(+-)} = 139.57041$ MeV ([2], see explanation below formula (23)).

Table 1 *Characteristic features of core of baryons*

Physical Quantity	Symbol	Theoretical value [2]
Mass of positively charged core of baryons	H^+	727.44 MeV
Mass of neutral core of baryons	H^o	724.78 MeV
Fine-structure constant	α_{EM}	1/137.036
Coupling constant for weak interactions of proton and electron	$\alpha'_{W(e-p)}$	$1.11943581 \cdot 10^{-5}$
Weak binding energy	E_W	14.980 MeV
Electromagnetic binding energy	E_{EM}	3.097 MeV
Mass of condensate	Y	424.124 MeV
Mass of muon	m_{muon}	105.656314 MeV
Lower limit for mass of a loop	m_{LL}	67.54441 MeV
Upper limit for mass of a loop	m_{UL}	727.44 MeV
Mass of electron/positron	$m_{electron}$	0.5109989 MeV
Mass of the boson characteristic for baryonic plasma	m_{boson}	~ 283 MeV
Mass of charged pion	$m_{pion(+,-)}$	139.57041 MeV

The calculated masses of proton and neutron are respectively $m_{proton} = 938.27$ MeV ([2], formula (40)), $m_{neutron} = 939.54$ MeV ([2], formula (41)).

Table 2 *Masses of nucleons*

Physical Quantity	Symbol	Theoretical value [2]
Mass of proton	m_{proton}	938.27 MeV
Mass of neutron	$m_{neutron}$	939.54 MeV

The physical quantities which appear in this paper, calculated within S-ST [2], are collected in Table 1 and Table 2.

Gluons and photons are the rotational energies of the Einstein-spacetime components. Inside the strong fields (they have internal helicity) the rotating Einstein-spacetime components behave as gluons whereas outside the strong fields (internal helicity is equal to zero) behave as photons. On the surfaces of the strong fields there is the gluon-photon transition [2].

Assume that due to the collisions of nucleons inside baryonic plasma (it consists of the cores of baryons [2]), inside the core of baryons appear weak condensates with energy/mass E. Due to the gluon-photon transition, they can leak outside the plasma but then their energy/mass must increase F >> 1 times (i.e. there is the cooling of the baryonic plasma)

$$F = \alpha_{EM} / \alpha'_{W(e-p)} = 651.88. \qquad (1)$$

In the S-ST there appears the four particles symmetry. The four particles symmetry follows from the fact that four particles can have total spin and total internal helicity equal to zero i.e. such objects do not create turbulences in spacetime at low and high energy.

Here, I will show that the positron fraction in primary cosmic rays as a function of energy and positron flux follow from the internal structure of the core of baryons and the phenomena characteristic for the baryonic plasma.

Here, as well within S-ST, I describe the origin of new cosmological problems which lead to new cosmology. They are as follows. There are not in existence the B-modes associated with gravitational waves – it leads to conclusion that there was a separation in time of the inflation and the big bang of the Universe or that luminal gravitational waves are not in existence (S-ST shows that both conclusions are correct). In the very distant Universe there is too small number of dwarf galaxies. In the very distant Universe there are the massive galaxies which do not significantly evolve so a time for their formation was too short. In the very distant Universe there are too many barred galaxies – it is inconsistent with simulations grounded on the Cosmological Standard Model (CSM). There is a substantial asymmetry in the CMB signal observed in the two opposite hemispheres of the sky. These new problems suggest that CSM starts from wrong initial conditions.

The scale-symmetric physics starts from the general-relativity vacuum equations concerning the inflating modified Higgs field composed of superluminal pieces of space (the big bang). The Kasner solution (1921) to the vacuum equations and the three additional laws of conservation lead to the four succeeding phase transitions of the modified Higgs field (due to the size of our Cosmos [4], the next phase transitions are impossible) and to the atom-like structure of baryons. Due to the four phase transitions, there are in existence the four scales i.e. the superluminal-quantum-entanglement scale, luminal Planck scale concerning the Einstein-spacetime components, observed-particles scale and cosmological scale.

2. The positron fraction and flux

The four particle symmetry is very important inside baryonic plasma. Notice also that E_W can decay to $4E_{EM}$. Calculate energy of positron produced in following process

$$\text{Nucleon} + \text{nucleon} \rightarrow F\,(E_W + 4E_{EM}) \rightarrow 2\,e^+ + 2\,(e^-)^*. \qquad (2)$$

Energy of the positron is $E_{LL,positron} = 8.9$ GeV (precisely, for $4E_{EM}$ is 8.08 GeV whereas for E_W is 9.77 GeV). It is the lower limit for energy of positron produced by the core of baryons in baryonic plasma for the interval with increasing positron fraction.

Notice that Y can decay to $4m_{muon}$. Calculate energy of positron in following process

$$\text{Nucleon} + \text{nucleon} \rightarrow F\,(Y + 4m_{muon}) \rightarrow 2\,e^+ + 2\,(e^-)^*. \qquad (3)$$

Energy of the positron is $E_{UL,positron} = 276.0$ GeV (precisely, for Y is 276.5 GeV whereas for $4m_{muon}$ is 275.5 GeV). It is the upper limit for energy of positron produced by the core of baryons in baryonic plasma for the interval with increasing positron fraction.

Calculate the positron fraction in cosmic rays for the lower and upper limits.

The lowest mass of a loop is m_{LL} and such loops appear on the circular axis of the torus whereas the highest mass of a loop is m_{UL} and such loops appear on the equator of the torus i.e. in the d = 0 state [2]. Since the four particles symmetry is very important in baryonic plasma so the number of positrons and electrons for the lower limit for the interval with increasing positron fraction (positron fraction = $R = e^+ / (e^+ + e^-)$) is proportional to $4m_{LL}$ whereas for the upper limit is proportional to $4m_{UL}$. On the other hand, the number of positrons for the lower limit is proportional to the mean mass of condensates carrying mass equal to E_W or $4E_{EM}$ i.e. $E_{LL,mean} = (E_W + 4E_{EM}) / 2 = 13.684$ MeV whereas for the upper limit is proportional to the mean mass of condensates carrying mass equal to Y or $4m_{muon}$ i.e. $E_{UL,mean} = (Y + 4m_{muon}) / 2 = 423.375$ MeV.

The positron fraction R for the lower limit is

$$R_{LL} = \{ e^+ / (e^+ + e^-) \}_{LL} = E_{LL,mean} / 4m_{LL} = 0.05065 \approx 0.05. \qquad (4)$$

The positron fraction for the upper limit is

$$R_{UL} = \{ e^+ / (e^+ + e^-) \}_{UL} = E_{UL,mean} / 4m_{UL} = 0.14550 \approx 0.15. \qquad (5)$$

Since there is the logarithmic scale so the positron fraction, for the interval with increasing positron fraction, as a function of energy of positrons E looks as follows

$$\log \{ e^+ / (e^+ + e^-) \} = a \log (E / E_0) + b, \qquad (6)$$

where $E_0 = 8.9$ GeV, $a = 0.31$ whereas $b = -1.30$. For energy E = 8.9 GeV is R = 0.050, for E = 30 GeV is R = 0.073, for E = 70 GeV is R = 0.095 and for E = 276 GeV is R = 0.145.

The characteristic features of the positron fraction in cosmic rays are as follows (**Figure 1.**).

2.1.

The mean energy at which the positron fraction begins to increase is 8.9 GeV (8.08 and 9.77 GeV) and is about 0.05.

2.2.
There exists the sharp structure/core-of-baryons with mass 727.44 MeV which leads to energy of positron about 474 GeV.
2.3.
The mean energy at which the positron fraction reaches its maximum is 276 GeV (275.5 and 276.5 GeV) and is about 0.15.
2.4.
The rate of increase with energy defines following function

$$\log R = a \log (E / E_0) + b. \tag{7}$$

2.5.
The increase in positron fraction follows from the phenomena characteristic for baryonic plasma. Such plasma consists of the cores of baryons which structure is described within the Scale-Symmetric Theory [2].
The obtained theoretical results for the positron fraction are consistent with the data from the Alpha Magnetic Spectrometer (AMS) on the International Space Station (ISS) [5].

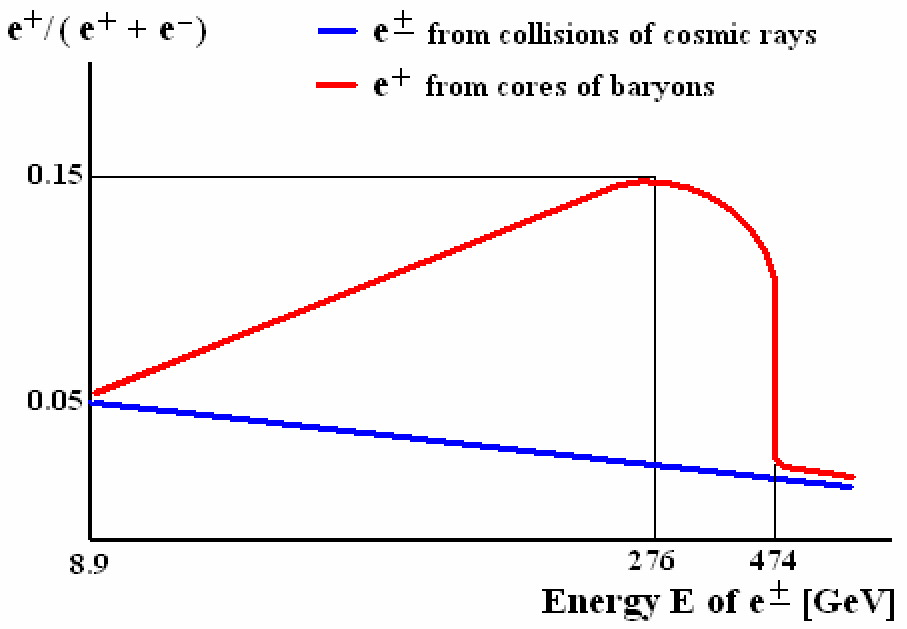

Figure 1. Illustration of the characteristic features of the positron fraction in cosmic rays within Scale-Symmetric Everlasting Theory.

Calculate the characteristic features for the positron flux (**Figure 2.**).
Due to the thermal motions of the cores of baryons in baryonic plasma, the positron flux should increase for following interval ($F\ m_{positron}$, $F\ E_{LL,mean}$) ≡ (0.33 GeV, 8.9 GeV). Next, for interval ($F\ E_{LL,mean}$, $F\ m_{muon}$) ≡ (8.9 GeV, 68.9 GeV), each core of nucleon can produce one positron so the positron flux should level out. Above 69 GeV, once again, due to the thermal motions, increases number of positively charged muons so number of positrons increases as well. Such increasing positron flux we should observe up to the upper limit $FE_{UL,positron}$ = 276 GeV. For energies higher than 276 GeV there are mostly produced the muon-antimuon pairs so positron flux should rapidly decrease.

We should observe a small increase in positron flux for $Fm_{pion(+)} \approx 91$ GeV and for $Fm_{boson} \approx 184$ GeV.

For $Fm_{muon} = 68.9$ GeV, the positron flux should be $H^+ / m_{LL} = 10.77$ times lower than electron flux.

Since the mass distance between neutron and proton is about two times smaller than the mass distance between the charged and neutral cores of baryons so for the lower limit 8.9 GeV the electron flux should be about two times higher than the positron flux. It follows from the fact that for energy 8.08 GeV there is the transition from the positively charged core of baryons to the neutral one ($H^+ - H^o \approx 2.66$ MeV) i.e. the transition from proton to neutron – in the beta decay of this neutron there appears electron (the total maximum energy of electron is $m_{neutron} - m_{proton} \approx 1.3$ MeV), proton and electron-antineutrino. We can see that $2.66/1.3 \approx 2$.

The obtained theoretical results for the flux are consistent with the data from the Alpha Magnetic Spectrometer (AMS) on the International Space Station (ISS) [6].

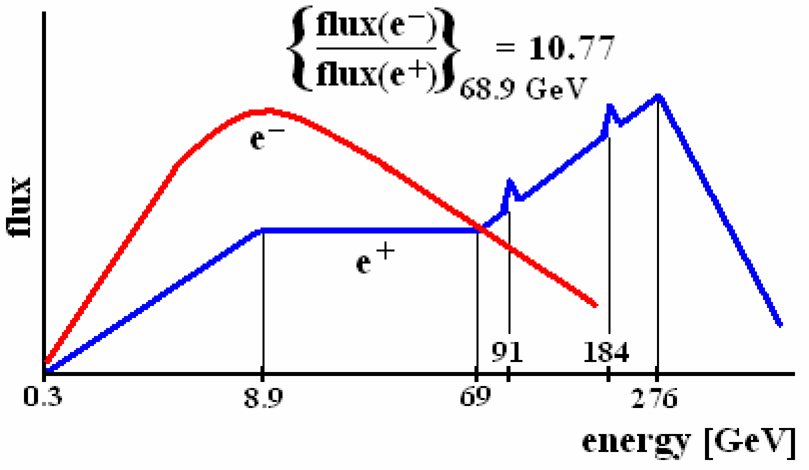

Figure 2. Illustration of the characteristic features of the positron flux in cosmic rays within Scale-Symmetric Everlasting Theory.

3. New cosmological problems

There appeared new cosmological problems which lead to new cosmology described within S-ST. They are as follows.

3.1.

There are not in existence the B-modes associated with gravitational waves – it leads to conclusion that there was a separation in time of the inflation and the big bang of the Universe or that luminal gravitational waves are not in existence.

It is consistent with new cosmology described within S-ST.

3.2.

In the very distant Universe there is too small number of dwarf galaxies.

According to the Cosmological Standard Model (CSM), the bigger cosmic structures have been forming due to the mergers of smaller structures. It leads to conclusion that at distant Universe we should see tremendous number of dwarf galaxies. On the other hand, the S-ST shows that the very early Universe was the double cosmic loop composed of binary systems of protogalaxies which consisted of the neutron black holes. The protogalaxies evolved due to the inflows of the dark matter into the double cosmic loop. Why we cannot see the first stage of evolution of the double cosmic loop? Why we already see the massive galaxies and massive black holes at the very distant Universe? The answer follows from the duality of relativity. The most distant galaxies are in the time distance equal to 13.866 ± 0.096 Gyr but they are already 7.75 Gyr old [2], [7], [8]. Just the real age of the Universe is 21.614 ± 0.096 Gyr.

3.3.

In the very distant Universe there are the massive galaxies which do not significantly evolve [9] so a time for their formation was too short. In the very distant Universe there are too many barred galaxies – it is inconsistent with simulations grounded on the Cosmological Standard Model (CSM) ([9], at z ~ 1.5, among the disc galaxies there is about 14% barred galaxies).

It is consistent with S-ST. The shape of the double cosmic loop caused that there were numerous groups of protogalaxies composed of four binary systems of protogalaxies. Some of them, due to the asymmetric inflows of the dark matter, decayed to the barred galaxies.

3.4.

There is a substantial asymmetry in the CMB signal observed in the two opposite hemispheres of the sky [10]. One of the two hemispheres appears to have a significantly stronger signal on average. It is inconsistent with CMS.

Such result is consistent with S-ST. Here [4] we can read that the Universe is moving with a sound speed equal to 355 m/s in relation to the Einstein spacetime. It causes that the frontal hemisphere is a little hotter.

Described above new cosmological problems suggest that CSM starts from wrong initial conditions. We can solve the new problems within the Scale-Symmetric Theory.

4. Summary

Here, within the Scale-Symmetric Theory (S-ST), I calculated the positron fraction in primary cosmic rays as a function of energy and described positron flux. Obtained results are consistent with the data from the Alpha Magnetic Spectrometer (AMS) on the International Space Station (ISS). These data lead to the internal structure of the core of baryons and to phenomena characteristic for regions in the Universe filled with baryonic plasma described within S-ST.

Here, as well within S-ST, I described new cosmological problems which lead to new cosmology. They are as follows. There are not in existence the B-modes associated with gravitational waves – it leads to conclusion that there was a separation in time of the inflation and the big bang of the Universe or that luminal gravitational waves are not in existence (S-ST shows that both conclusions are correct). In the very distant Universe there is too small number of dwarf galaxies. In the very distant Universe there are the massive galaxies which do not significantly evolve so a time for their formation was too short. In the very distant Universe there are too many barred galaxies – it is inconsistent with simulations grounded on the Cosmological Standard Model (CSM). There is a substantial asymmetry in the CMB signal observed in the two opposite hemispheres of the sky. These new problems suggest that CSM starts from wrong initial conditions. On the other hand, new observational facts are consistent with new cosmology described within Scale-Symmetric Physics.

References

[1] Sylwester Kornowski (17 September 2014). “The Scale-Symmetric Physics”
http://vixra.org/abs/1409.0137 .

[2] Sylwester Kornowski (23 February 2015). “The Scale-Symmetric Physics”
http://vixra.org/abs/1203.0021 .

[3] Sylwester Kornowski (29 January 2013). “The Root-Mean-Square Charge Radius of Proton”
http://vixra.org/abs/1301.0174 .

[4] Sylwester Kornowski (5 September 2013). “The Origin and Fate of the Cosmos and Universes and the Classical-Quantum Asymmetry”
http://vixra.org/abs/1308.0138 .

[5] L. Accardo *et al.* (AMS Collaboration), (18 September 2014). “High Statistics Measurement of the Positron Fraction in Primary Cosmic Rays of 0.5–500 GeV with the Alpha Magnetic Spectrometer on the International Space Station”
Phys. Rev. Lett. **113**, 121101 .

[6] M. Aguilar *et al.* (AMS Collaboration), (18 September 2014). “Electron and Positron Fluxes in Primary Cosmic Rays Measured with the Alpha Magnetic Spectrometer on the International Space Station”.
Phys. Rev. Lett. **113**, 121102 .

[7] Sylwester Kornowski (26 May 2014). “The Duality of Relativity”
http://vixra.org/abs/1405.0327 .

[8] Sylwester Kornowski (21 June 2014). “The Evolution of Massive Galaxies”
http://vixra.org/abs/1406.0014 .

[9] B. D. Simmons *et al.*, “Galaxy Zoo: CANDELS Barred Disks and Bar Fractions”
Monthly Notices of the Royal Astronomical Society, 2014
DOI:10.1093/mnras/stu1817 .

[10] http://www.aanda.org/index.php?option=com_toc&url=/articles/aa/abs/2014/11/contents/contents.html .