The Large-Scale Structure of the Universe

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Abstract: A single equation within Theory of Everything would be infinitely complex so we should formulate a fractal skeletal theory which should lead to the much simpler partial theories. In such theory should not appear free parameters and the indeterminate mathematical forms. The Scale-Symmetric Theory (SST) is such a skeletal theory. Its structure looks as a Christmas tree. Here, within a model which is self-similar/dual to the structure of baryons, applying the SST, we calculated the median effective radius of the Type 1 cosmological voids in observed redshift coordinates, number of such voids in the Universe, the quantized median effective radii of such voids, radius of the WMAP Cold Spot and the Cosmological Ruler. Obtained results are consistent with observational facts. Moreover, there is calculated the expected void abundance. Presented here theoretical results suggest that the picture of the high-redshift Universe obtained within the mainstream cosmology is misshapen.

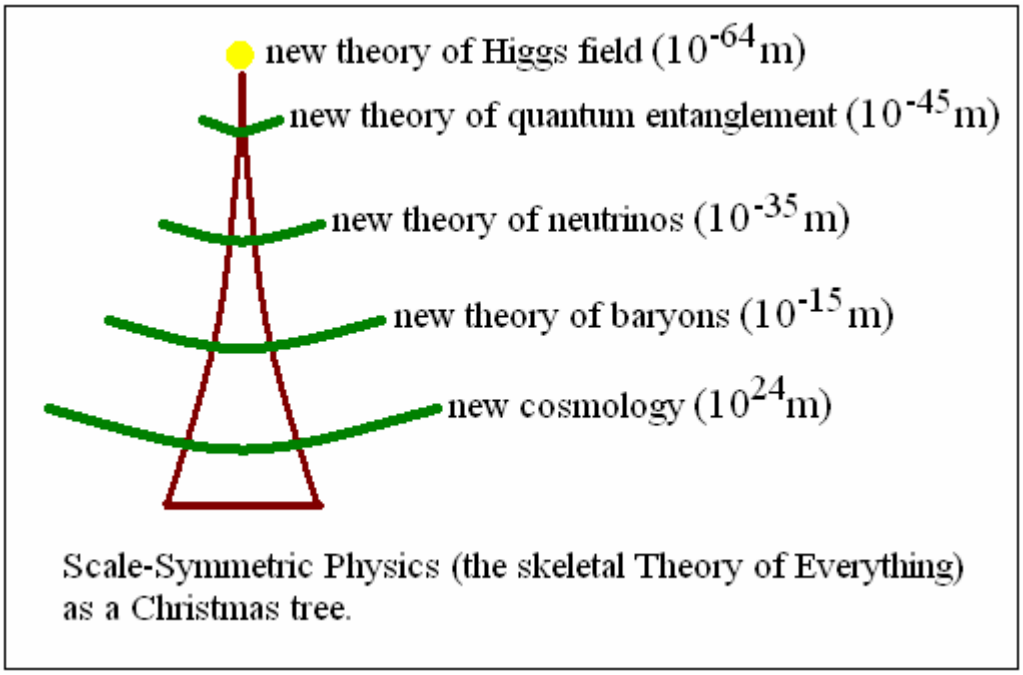
1. Introduction

Here, applying the Scale-Symmetric Theory (SST), [1], we calculated the median effective radius of the Type 1 cosmological voids in observed redshift coordinates, number of such voids in the Universe, the quantized median effective radii of such voids, radius of the WMAP Cold Spot and the Cosmological Ruler.

The revealed here anomalies for higher redshift lead to conclusion that our picture of the high-redshift Universe is misshapen – the SST shows that it follows from the fact that in mainstream cosmology is applied formula which incorrectly describes expansion of the Universe, especially for high redshift.

Most important is following question: How should look the theory of everything (ToE)? There is tremendous number of very different problems still unsolved so we cannot write a single equation. Just such an equation would be infinitely complex. It suggests that structure of a useful ToE must be different. We should formulate a fundamental skeletal theory that should lead to the partial theories concerning more and more selected problems. The skeletal theory should look like a Christmas tree. We need a trunk of the Christmas tree leading to the main branches (boughs). How such trunk should look? An extension of the General Theory of Relativity leads to the inflation field – it is the superluminal non-gravitating Higgs field composed of tachyons [1A]. The succeeding phase transitions of the Higgs field lead to fields with new properties [1A]. Such widening trunk (we are going from the top to the base of the

Christmas tree) should look as a fractal i.e. the partial theories represented by the lower and lower boughs should be at least partially self-similar/dual. Such skeletal ToE should show why unification of Gravity and Quantum Physics is impossible. There as well should not appear free parameters and indeterminate mathematical forms. The Scale-Symmetric Theory is the skeletal ToE (see Fig.).



Scale-Symmetric Physics (the skeletal Theory of Everything) as a Christmas tree.

The new cosmology, [1B], leads to the Protoworld which appeared due to a fluctuation of the luminal gravitating Einstein spacetime after the inflation (the big bang) but before the expansion of the Universe (the "soft" big bang) – it was composed of nucleons and electrons. There was the Cosmic Torus – its external radius was $A_C \approx 87.9$ Mpc $= 62.4$ [h^{-1} Mpc], for $h = 0.71$ (we use this value to compare our results with other results [2]). There was the central condensate and a ring with radius $R_C \approx A_C + B_C \approx 151.13$ Mpc $= 107.3$ [h^{-1} Mpc] (it is the Standard Ruler in cosmology [3]).

The very early Universe appeared as the Double Cosmic Loop (DCL) inside the Cosmic Torus [1B]. It was built of protogalaxies grouped due to the four-object symmetry into larger structures already before the expansion of the Universe [1B]. Radius of the DCL was $R_{DCL} \approx 58.6$ Mpc $= 41.6$ [h^{-1} Mpc]. When the Protoworld transformed into the dark matter and dark energy, due to the tremendous temperature, there dominated the symmetrical decays of masses in the DCL, [1B], – the products, first of all, were moving perpendicularly to DCL so there appeared the central condensate and ellipsoid with the maximum equatorial radius equal to the maximum radius of the Schwarzschild surface of the DCL: $R_{E\text{-}DCL} = 2R_{DCL} \approx 117.2$ Mpc $= 83.2$ [h^{-1} Mpc] (it is close to the radius of the WMAP Cold Spot). The initial void/spot mimicked the BAO. When the Universe started to expand, there appeared many such voids. But because the CMB was created at the beginning of the expansion of the Universe so in CMB is only one such Cold Spot.

2. The median effective radii for Type 1 voids calculation

In the Basic Type voids about 31% of them are the Type 1 voids [2], [4].

Since the Universe is expanding and due to the four-object symmetry, each initial biggest void with radius $R_{E\text{-}DCL}$ decayed to 4 smaller voids, each smaller void decayed to 4 smaller voids, and so on. Radius of next smaller void is $F = 4^{1/3} = 1.5874$ times smaller. It is due to following formula

$$4 \pi R_{n+1}^3 / 3 = 4 \pi R_n^3 / (3 \cdot 4). \quad (1)$$

The Type 1 voids are defined here [2]. We apply the same definition. The median effective radii for Type 1 voids we can calculate from following formula

$$R_n = 2R_{DCL} / F^n. \quad (2)$$

where $n = 0, 1, 2, 3, 4, 5$.

We obtain (in the round brackets are the results obtained on the base of the mainstream cosmology [2]): $R_0 = 83.2$ [h^{-1} Mpc] (~150), $R_1 = 52.4$ [h^{-1} Mpc] (~73), $R_2 = 33.0$ [h^{-1} Mpc] (~37), $R_3 = 20.8$ [h^{-1} Mpc] (~21), $R_4 = 13.1$ [h^{-1} Mpc] (~13), $R_5 = 8.3$ [h^{-1} Mpc] (~9). We can see that for the low-redshift Universe, i.e. for $n = 5$, 4 and 3, both results, i.e. obtained here and within the mainstream cosmology, are close one to other, whereas for higher redshift, i.e. for $n = 2$, 1 and 0 are more and more inconsistent. The revealed here anomalies for higher redshift lead to conclusion that our picture of the high-redshift Universe is misshapen and the SST shows the origin – it follows from the fact that we neglect existence and evolution of the Protoworld and we neglect the duality of relativity described within SST [1B]. The misshapen picture leads as well to an illusion of acceleration of expansion of the Universe. The last results, [5], show that there are in existence not recognized before the two distinct colour groups of the Type Ia supernovae. It leads to conclusion that the distant Type Ia supernovae are less fainter than it was assumed i.e. the postulated acceleration can be indeed an illusion as it is proved within SST [6].

3. Void number calculation

The criteria employed for selection of voids are as in [2]. The Type 1 voids are the subset of Basic Type voids that have $\rho_{minimum} < 0.3\ \rho_{mean}$, irrespective of their density ratios ($\rho_{void} = n_{gal} / V_{void}$; $\rho_{mean} = N_{sample} / V_{sample}$).

We calculated the upper limit for the Type 1 voids, $R_0 = 83.2$ [h^{-1} Mpc]. Calculate the lower limit. Mean thickness of the filaments and walls is about 15 Mly = 3.26 [h^{-1} Mpc]. We can compare it with $R_6 = 5.2$ [h^{-1} Mpc] (formula (2)). Such voids most often are irregular so due to the filaments/void proportions it is very difficult to recognize them. But they are in existence. We assume that the lower limit for radius of voids which appear in catalogue is about 8.3 [h^{-1} Mpc].

Calculate mean number of voids in the characteristic volume/sphere with radius $R_{E\text{-}DCL} = 83.2$ [h^{-1} Mpc] – its volume is $V_{Ch} \approx 2.4 \cdot 10^6$ [h^{-1} Mpc]^3. There is following number, N, of such volumes in the present-day Universe ($R_{Universe} \approx 3004$ [h^{-1} Mpc])

$$N = 4 \pi R_{Universe}^3 / (3 V_{Ch}) \approx 4.7 \cdot 10^4. \quad (3)$$

Due to the four-object symmetry, in one characteristic volume can be 1 void or 4 voids or 16 voids or 64 voids or 256 voids or 1024 voids i.e. the arithmetic mean is

$$N_{Ch,mean} = (1 + 4 + 16 + 64 + 256 + 1024) / 6 = 227.5 \text{ voids.} \quad (4)$$

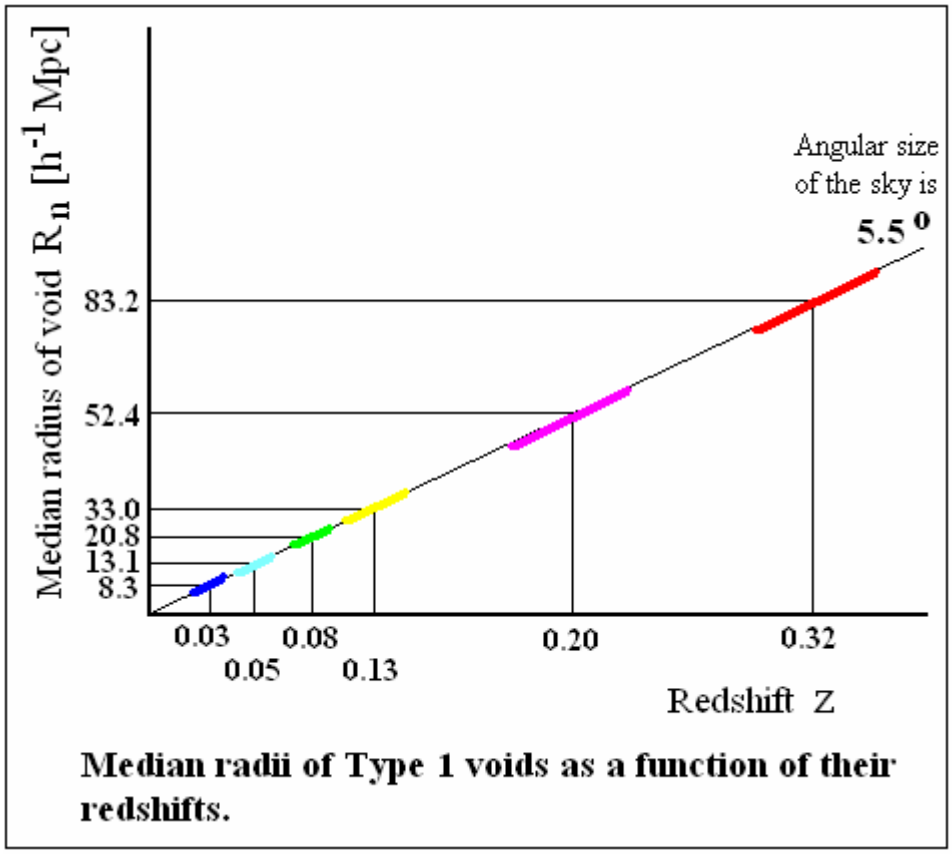
It leads to conclusion that total number of considered voids should be $N_{Total} = 1.08 \cdot 10^7$.

4. Radius of cosmological voids in redshift coordinates

The radial speed of the voids could be very close to the speed of light in "vacuum", c, when they get out of the strong gravitational field of the Double Cosmic Loop. There is an analogy of the nuclear strong field in baryons and the strong gravitational field produced by the DCL. According to SST, the range of the strong interactions of baryons is about $2\pi \cdot 2A/3 = 4\pi A/3 = 2.92$ fm (more precise calculation leads to 2.958 fm [1A]) where A is the equatorial radius of the torus in the core of baryons which is composed of entangled carriers of gluons [1A]. Since the fundamental structures are self-similar/dual so range of the strong gravitational interaction was $R_{G\text{-}range} \approx 4\ \pi\ A_C\ /\ 3 = 261.4$ [h^{-1} Mpc] and according to SST, for such range the observed redshift is $z = 1$. From this condition we obtain

$$R_n = R_{G\text{-}range}\ z. \quad (5)$$

Formula (5) shows that the obtained here theoretical results are consistent with observational results [2]. For R_5 is $z = 0.03$, for R_4 is $z = 0.05$, for R_3 is $z = 0.08$, for R_2 is $z = 0.13$, for R_1 is $z = 0.20$, and for R_0 is $z = 0.32$ (see Fig.).



Median radii of Type 1 voids as a function of their redshifts.

5. Summary

A single equation within Theory of Everything would be infinitely complex so a useful ToE should start from a fractal skeletal theory which should lead to the much simpler partial

theories. In such theory should not appear free parameters and the indeterminate mathematical forms. The Scale-Symmetric Theory is such a skeletal theory. Its structure looks as a Christmas tree.

Here, within a model that is self-similar/dual to the structure of baryons, applying the SST, we calculated the median effective radius of the Type 1 cosmological voids in observed redshift coordinates: $R_n = 261.4\ z$ [h^{-1} Mpc] on the assumption h = 0.71, number of such voids in the Universe: $N_{Total} = 1.08 \cdot 10^7$, the quantized median effective radii: 83.2 [h^{-1} Mpc], 52.4 [h^{-1} Mpc], 33.0 [h^{-1} Mpc], 20.8 [h^{-1} Mpc], 13.1 [h^{-1} Mpc], 8.3 [h^{-1} Mpc], radius of the WMAP Cold Spot: 117.2 Mpc, and the Cosmological Ruler: 151.13 Mpc. Obtained results are consistent with observational facts. Moreover, there is calculated the expected void abundance.

Presented here theoretical results suggest that the picture of the high-redshift Universe obtained within the mainstream cosmology is misshapen.

References

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