The Origin of the Standard Ruler in Cosmology

Sylwester Kornowski

Abstract: It is assumed that the not numerous pairs of galaxies separated by about 150 Mpc appeared due to baryon acoustic oscillations (BAO). We can use this distance as the standard ruler in cosmology. On the other hand, the scale-symmetric Everlasting Theory shows that the four succeeding phase transitions of the modified Higgs field lead to the cosmic object/Protoworld which was created after the inflation but before the observed expansion of the Universe. Due to the quantum entanglement, the internal structure of the Protoworld leaks to the Einstein spacetime. It causes that in the Einstein spacetime appear virtual structures and flows which mimic the structure and characteristic motions in the Protoworld. Due to the quantum entanglement of moving Einstein spacetime components with gas and dust, the baryonic matter gathers in a centre, torus and loop which size is greatest. Calculated here the radius of the loop is 151.13 Mpc and such is the true origin of the standard ruler in cosmology. Due to the spontaneous succeeding phase transitions of the modified Higgs field, the real and virtual protons are some miniatures respectively of the real and virtual Protoworld. It means that the virtual Protoworlds appear even in absence of the real Protoworld because then the virtual Protoworlds are produced by baryonic matter.

1. Introduction and calculations

There is a small excess in number of pairs of galaxies separated by ~500 million light-years (~153.3 Mpc). It is often referred to as the baryon acoustic oscillations (BAO). On basis of this phenomenon we can investigate some properties of dark energy.

There is assumed existence in very early Universe regions filled with dark matter, baryons and photons. The heat of matter-photon interactions caused that there appeared dynamic pressure. The counteracting gravity and pressure created oscillations. The wave traveled outwards with the sound speed equal to 57% of the speed of light. Photons providing pressure decoupled at recombination and it fixed radius of the shell of baryonic matter. This radius is referred to as the sound horizon. The gas in the shell and dark matter in the original centre started the galaxies formation. The preferred separation was ~150 Mpc [1], [2], [3].

The analysis of the WMAP data (CMB) yielded 146.8 ± 1.8 Mpc for the sound horizon at the photon decoupling epoch and 153.3 ± 2.0 Mpc at the end of the baryon drag epoch [4].

The standard ruler can be used to measure the geometry of the Universe via measurement of both the angular diameter distance $D_A(z)$ and the expansion rate $H(z)$.

Here I will prove that the origin of the above described phenomenon is different.

The scale-symmetric Everlasting Theory, [5] (the foundations) and [6], starts from the expansion of the cracked space (it is the inflation of the modified Higgs field – the big bang) which leads to the Einstein spacetime (E spacetime). There appear the four succeeding phase transitions of the modified Higgs field (due to the size of our Cosmos, the next phase transitions are impossible) and the atom-like structure of baryons. The atom-like structure of baryons leads to the exact mass, spin and radius of proton.

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 E-spacetime components, observed-particles scale and cosmological scale concerning the Protoworld which appeared after the inflation (the big bang) but before the observed expansion of the Universe (the 'soft' big bang). Just the Everlasting Theory is the scale-symmetric theory [7]. The scales are partially dual i.e., for example, there is an analogy between the strong-weak interactions concerning the observed-particles scale (the torus in the core of baryons behaves as the black hole in respect of the strong interactions whereas the condensate in its centre behaves as weak black hole) and strong gravitational interactions concerning the cosmological scale.

The gluons and photons are the rotational energies of the E-spacetime components. Outside the strong fields, the gluons behave as photons [5]. This and the entanglement cause that the virtual structure of protons leaks from proton ([5] – see Chapter "Proton and Loops as Foundation of Theory of Chaos"). This means that in the E spacetime appear virtual structures which mimic the internal motions in proton. Since the succeeding phase transitions concern the virtual structures as well so in the E spacetime are virtual structures which mimic the motions in the Protoworld (even in absence of the real Protoworld). The quantum entanglement of the E-spacetime components with matter causes that distribution of matter mimics the distribution of matter that was in the Protoworld. It is the advection. Here, the advection is the transport mechanism of the mass of gas and dust by the entangled E-spacetime components due to the characteristic motions in the virtual structures. Distribution of matter in a proton is a miniature of distribution of baryonic matter caused by the characteristic motions in the virtual Protoworlds.

The core of proton consists of the condensate composed of the confined E-spacetime components – it is the black hole with respect of the weak interactions and its rest mass is $Y \approx 424.1$ MeV [5]. The weak black hole is in centre of a torus which mean radius is $F \approx 53.4$ times greater than the weak black hole. The torus inside the core of nucleons has left-handed internal helicity, its rest mass is $X \approx 318.3$ MeV and external radius is $A = 0.6974425$ fm [5]. On the shell outside the torus is relativistic pion. Radius of the circular shell is $A + B = 1.19928$ fm [5].

The external radius of the cosmic torus in Protoworld follows from the phase transitions – it leads to $A_{Protoworld} = 2.71199 \cdot 10^{24}$ m $= 286.66$ million light-years [5]. The calculated radius of the cosmic circular shell is

$$R_{ruler-in-cosmology} = A_{Protoworld} (A + B) / A = 492.93 \text{ million ly} = 151.13 \text{ Mpc.} \quad (1)$$

Here [8], the mean value for sound horizon obtained on the basis of their fiducial cosmology and on the basis of definition of the sound horizon in C_{AMB} is 151.24 Mpc – it means that the obtained here theoretical result is very close to this result.

3. Summary

It is assumed that the not numerous pairs of galaxies separated by about 150 Mpc appeared due to baryon acoustic oscillations (BAO). We can use this distance as the standard ruler in cosmology.

On the other hand, the scale-symmetric Everlasting Theory shows that the four succeeding phase transitions of the modified Higgs field lead to the cosmic object/Protoworld which was created after the inflation but before the observed expansion of the Universe. Due to the quantum entanglement, the internal structure of the Protoworld leaks to the Einstein spacetime. It causes that in the Einstein spacetime appear virtual structures and flows which mimic the structure and characteristic motions in the Protoworld. Due to the quantum entanglement of moving Einstein spacetime components with gas and dust, the baryonic matter gathers in a centre, torus and loop which size is greatest. Calculated here the radius of the loop is 151.13 Mpc and such is the true origin of the standard ruler in cosmology. Due to the spontaneous succeeding phase transitions of the modified Higgs field, the real and virtual protons are some miniatures respectively of the real and virtual Protoworld. It means that the virtual Protoworlds appear even in absence of the real Protoworld because then the virtual Protoworlds are produced by baryonic matter.

The obtained result is consistent with observational facts.

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