Weak Interaction as the Origin of the Hubble Tension

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Abstract: Here we show that the Hubble tension, i.e. the two different values of the Hubble constant for the early Universe (about 68) and near Universe (about 74), is the result of a step change in the value of the density parameter for the part of baryonic matter that due to the weak force interacts with dark matter.

1. Introduction

The weak interaction of baryonic matter with the dark-matter (DM) loops via the virtual electron-positron pairs, which is described within the Sale-Symmetric Theory (SST) [1], has a dominant effect on the coherence of the expanding Universe so the Hubble constant, H_o, should depend on the density parameter defining the abundance of such interaction.

The SST shows that initially the DM loops overlapped with the cores of the compact protogalaxies. With time, due to the evolution of the protogalaxies, the DM loops picked up the angular momentum of baryonic matter, so their radii increased. Currently, DM loops only slightly overlap with baryonic matter, so the influence of baryonic matter on the Hubble constant can be neglected. On the other hand, we cannot neglect the dependence of the Hubble constant on the dark matter density parameter Ω_{DM}.

As a summary, we can say that initially the impact of the weak interaction on value of H_o was greater because it concerned both dark matter and baryonic matter. Now, we only have to consider dark matter so the Hubble constant has a higher value because from the definition of the density parameter, Ω_M, and formula for the critical density, ρ_c, of the Friedmann universe for $\Lambda=k=0$ [2]

$$\Omega_M = \rho_M / \rho_c = 8 \pi G \rho_M / (3 H_o^2) , \qquad (1)$$

where ρ_M is the actual density and G is gravitational constant, results that the Hubble constant is inversely proportional to the square root of the density parameter

$$H_{o,i} / H_{o,mean} = (\Omega_{M,mean} / \Omega_{M,i})^{1/2} , \qquad (2)$$

where i = early or near (Universe) or mean (value), and $H_{o,mean} = 70.52\ km \cdot s^{-1} \cdot Mpc^{-1}$ is the mean value of the Hubble constant obtained within SST (see formula (30) in [3]).

2. Calculations

Within SST we calculated [3]

$$\text{*the baryon density parameter: } \Omega_B = 0.0491, \tag{3a}$$

$$\text{*the dark matter density parameter: } \Omega_{DM} = 0.2646. \tag{3b}$$

Similar values are obtained by the Planck Collaboration: 0.0486 ± 0.0010 and 0.2589 ± 0.0057 respectively [4].

The mean value of the density parameter for the weak interaction of the baryonic matter and dark matter is

$$\Omega_{M,mean} = \Omega_{DM} + \Omega_B / 2 = 0.28915 \,. \tag{4}$$

The density parameter for the weak interaction for the near Universe is

$$\Omega_{M,i} = \Omega_{M,near} = \Omega_{DM} = 0.2646 \,. \tag{5}$$

From (2), (4) and (5) we obtain

$$H_{o,near} = H_{o,mean} \, (\Omega_{M,mean} / \Omega_{DM})^{1/2} = 73.72 \,. \tag{6}$$

The density parameter for the weak interaction for the early Universe is

$$\Omega_{M,i} = \Omega_{M,early} = \Omega_{DM} + \Omega_B = 0.3137 \,. \tag{7}$$

From (2), (4) and (7) we obtain

$$H_{o,early} = H_{o,mean} \, \{\Omega_{M,mean} / (\Omega_{DM} + \Omega_B)\}^{1/2} = 67.70 \,. \tag{8}$$

3. Summary

The recent measurements of the Hubble constant (since 16 October 2017) are as follows [5] – we created three groups of the central values of the Hubble constant:

A: 73.9, 74.2, 76.8, 73.5, 73.3, 74.03, 72.5, 73.52, 73.45 – the mean central value is 73.9.

The measurement techniques promoted lower values of redshift so they concern the near Universe.

In the group A, the most precise central value is 74.03 (i.e. 74.03 ± 1.42 for Cepheids in the Large Magellanic Cloud [6]). On the other hand, for the near Universe we obtained here 73.72 so we have 73.72 versus 74.03 ± 1.42.

B: 70.3, 69.8, 70.3, 70.0 – the mean central value is 70.1.

The measurement techniques promoted the mean value of the Hubble constant for the early and near Universe.

In the group B, the most precise central value is 70.3 (i.e. $70.3^{+1.36}_{-1.35}$ from low-redshift cosmological data but including BAO measurements [7]). On the other hand, the mean value obtained within SST is 70.52 (see formula (30) in [3]) so we have 70.52 versus $70.3^{+1.36}_{-1.35}$.

C: 68.0, 67.78, 67.77, 67.66 – the mean central value is 67.8

The measurement techniques promoted the Hubble constant for the early Universe because of the CMB/BAO measurements.

In the group C, the most precise central value is 67.78 (i.e. $67.78^{+0.91}{}_{-0.87}$ from angular size of quasars and from BAO [8]). On the other hand, for the early Universe we obtained here 67.70 so we have 67.70 versus $67.78^{+0.91}{}_{-0.87}$.

The separation of the dark-matter loops from the cores of massive galaxies took place in a relatively short time on a cosmological scale, so we should observe two values of the Hubble constant, i.e. about 68 for the early Universe and about 74 for the near Universe.

Notice that the two values ~68 and ~74 lead to the true nature of dark matter.

But emphasize that the mean value 70.52 is for an observer on the Earth. According to SST, a photon is moving with the speed of light in "vacuum" c only in relation to a system with which it is entangled so the real value of the Hubble constant is ~45.2 [9].

In the early Universe, baryonic matter, due to its weak interactions with dark matter, increased the weight of the dark-matter loops which had and continue to have a great impact on the Universe's compactness, i.e. dark-matter loops wants to slow down the Universe's expansion forced by dark energy [3].

There is an excess of small-scale gravitational lenses observed in galaxy clusters [10] so my hypothesis that dark matter is in the form of loops (initially there were the DM tori with a mass of 727.43 MeV which decayed to the DM loops [11]) that can exchange angular momentum with baryonic matter (i.e. the DM loops can change their radius) is supported by observational data.

The expansion of the Universe was separated in time from the SST inflation. Our Cosmos has a stable boundary with a radius of $\sim 2 \cdot 10^{30}$ m [3] so the fundamental physical constants, i.e. gravitational constant and Planck constant, are invariant. On the other hand, the expansion of the Universe is forced by the SST dark energy [3], [12].

SST shows that initially, just before the expansion of the Universe, there were protogalaxies built of the neutron black holes [3]. It leads to conclusion that at the beginning of the expansion abundance of the collisions of the SST black holes was much higher than it is assumed in the mainstream cosmology. So today abundance of the heavy elements should be higher than it follows from the mainstream models – the last observations show that it is true [13].

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