Another look at the cosmological constant

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In the Planck Model, low energy scales are related to Planck scale by exponential factors that arise from the geometry of an AdS_6 x S^4 spacetime. The dark energy (vacuum energy) density, manifested in the cosmological constant, is similarly related to Planck scale. By assuming that the characteristic scale of the vacuum is the Bohr radius, the dark energy density may be calculated from the zero-point energy at Planck scale. The dark energy density is found to be 123 orders of magnitude smaller than Planck scale and to be equal to the value calculated from the results of the fit made with WMAP9 data to the base ΛCDM model.

1. Introduction

A relationship has been established between the dark energy density and zero-point energy at Planck scale [1]. That relationship was founded on an AdS_5 x S^5 spacetime, although in the Planck Model particle phenomena are consistent with an AdS_6 x S^4 spacetime [2]. Here, the dark energy density is shown to be related to zero-point energy at Planck scale by way of an AdS_6 x S^4 spacetime.

2. The dark energy density

Zero-point energy at Planck scale is of value $\frac{1}{2}\hbar\omega_P$. In Planck units, the zero-point energy $E_{0,P}$ is given by

$$E_{0,P} = \tfrac{1}{2} \tag{1}$$

At the scale of the vacuum, assumed to be the Bohr radius, Planck-scale physics is reduced in scale by an exponential factor $(\pi/2)^{-125} = l_P/a_0$, where l_P is the Planck length and a_0 is the Bohr radius [3]. The vacuum energy $E_{0,V}$, is given, in Planck units, by

$$E_{0,V} = \tfrac{1}{2}(l_P/a_0) \tag{2}$$

This energy is contained within an S^4, of radius a_0 as measured in the four-dimensional vacuum, at every point within the vacuum. The dark energy (vacuum energy) density ρ_Λ is given, in Planck units, by

$$\rho_\Lambda = E_{0,V}(l_P/a_0)^4 \tag{3}$$

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Combining (2) and (3) gives

$$\rho_\Lambda = ½(l_P/a_0)^5 \tag{4}$$

which has the value 1.33×10^{-123}. The results ($H_0 = 70.0 \pm 2.2\ km.s^{-1}Mpc^{-1}$; $\Omega_\Lambda = 0.721 \pm 0.025$) from a fit to the base ΛCDM model using WMAP9 data [4] suggest, since $\rho_\Lambda = \Omega_\Lambda \times 3{H_0}^2/8\pi G$, that $\rho_\Lambda = 1.33 \pm 0.08 \times 10^{-123}$. The results ($H_0 = 67.4 \pm 1.4\ km.s^{-1}Mpc^{-1}$; $\Omega_\Lambda = 0.686 \pm 0.020$) from a fit to the base ΛCDM model using Planck data [5] suggest that $\rho_\Lambda = 1.25 \pm 0.05 \times 10^{-123}$.

Since $a_0 = (\pi/2)^{125} l_P$,

$$\rho_\Lambda = 0.5 \times (\pi/2)^{-625} \tag{5}$$

in the Planck Model. WMAP9 data suggest that $\rho_\Lambda = 0.50 \pm 0.03 \times (\pi/2)^{-625}$. Planck data suggest that $\rho_\Lambda = 0.47 \pm 0.02 \times (\pi/2)^{-625}$.

In Planck units, the cosmological constant Λ is 8π times greater than the value of ρ_Λ in Planck units:

$$\Lambda = 4\pi \times (\pi/2)^{-625} \tag{6}$$

which is equal to 3.34×10^{-122}.

3. Conclusions

1. Dark energy is vacuum energy.
2. The cosmological constant is a manifestation of dark energy.
3. The dark energy density has the value 1.33×10^{-123} in Planck units.
4. The cosmological constant has the value 3.34×10^{-122} in Planck units.
5. The Bohr radius is the characteristic scale of the vacuum.

4. References

1. BF Riley, viXra:1307.0107
2. BF Riley, arXiv:0809.0111
3. BF Riley, viXra:1305.0061
4. G Hinshaw et al., arXiv:1212.5226v3
5. Planck Collaboration, arXiv:1303.5076v1