Invention of a link between the Casimir effect, the quantum vacuum energy and the cosmological constant

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Abstract.

We propose a simple relation to obtain the energy density of the cosmological constant from Planck units and the value of the cosmological constant. Then we join the latter with the zero point energy to find the Casimir effect.

Keywords: Casimir effect, cosmological constant, zero point energy, Planck constant, light speed.

Introduction.

To date, and to the best of the author's knowledge, there is no connection between Planck units and the cosmological constant Λ. We will propose in this short paper an empirical determination of the density of the cosmological constant using these data. Then we relate the quantum vacuum energy of quantum field theory and the energy of the cosmological constant to the Casimir effect.

Consider,
- the reduced Planck constant :

$$\hbar = 1,054572\ 10^{-34} kg\ m^2/s$$

- the Planck time :

$$t_{Pl} = 5,391246\ 10^{-44} s$$

- the Planck volume :

$$V_{Pl} = l_{Pl}^3 = (1,616255\ 10^{-35})^3$$

$$V_{Pl} = 4,222111167\ 10^{-105} m^3$$

- the Planck force :

$$F_{Pl} = 1,2103\ 10^{44}\ N$$

- the cosmological constant Λ, for H Hubble constant = 67.66 km/s/Mpc :

$$\Lambda = 1,1056\ 10^{-52}\ m^{-2}$$

- and for a density parameter of the cosmological constant Ω_Λ=0 ,6889

We have the energy density of the cosmological constant :

$$\rho_\Lambda \ c^2 = \frac{F_{Pl} \ \Lambda}{8\pi} \ \frac{kg}{m \ s^2}$$

$$\rho_\Lambda \ c^2 = 5,3239 \ 10^{-10} \ J/m^3$$

Or in an extended way with Planck units and empirically :

$$\rho_\Lambda = \frac{\hbar \ t_{Pl} \ \Lambda}{8\pi V_{Pl}} \ kg/m^3$$

The demonstration with the definition of the Planck units is easy. The author will not dwell on it.

With :

$$V_{Pl} = l_{Pl} \ l_{Pl}^2$$

hence :

$$\rho_\Lambda \ c^2 = \frac{\hbar \ t_{Pl} \ \Lambda \ c^2}{8\pi l_{Pl} \ l_{Pl}^2} \ \frac{kg}{m \ s^2}$$

$$\rho_\Lambda \ c^2 = \frac{\hbar \ \ \Lambda \ c}{8\pi \ l_{Pl}^2} \ \frac{kg}{m \ s^2}$$

$$\rho_\Lambda \ c^2 = \Lambda \ l_{Pl}^{-2} \ \frac{\hbar \ c}{8\pi} \ \frac{kg}{m \ s^2} \tag{1}$$

From the dimensional point of view, the Casimir effect, with *k* complexè number, F Casimir force and S surface of the Casimir effect plates, is the following:

$$\frac{dF}{dS} = k \ \frac{\hbar \ c}{L^4} \ \frac{kg}{m \ s^2} \tag{2}$$

To identify (1) to (2) we assume:

$$\frac{1}{L^4} = \Lambda \ l_{Pl}^{-2}$$

and,

$$k = \frac{1}{8 \ \pi}$$

or again :

$$dF = F_{Pl}$$

and,

$$\frac{1}{dS} = \Lambda$$

Conclusion

We have empirically determined the energy density of the cosmological constant with Planck units.

Then we identified the cosmological and quantum energy of the vacuum with the Casimir effect.

This seems to confirm that the cosmological constant of general relativity is an energy of the cosmological vacuum.

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