

# 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  $\Lambda$ . 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 :

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

- the Planck time :

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

- the Planck volume :

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

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

- the Planck force :

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

- the cosmological constant  $\Lambda$ , for H Hubble constant = 67.66 km/s/Mpc :

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

- and for a density parameter of the cosmological constant  $\Omega_\Lambda = 0,6889$

We have the energy density of the cosmological constant :

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

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

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 :

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

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

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

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:

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

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

$$\frac{1}{L^4} = \Lambda l_{Pl}^{-2} \quad (3)$$

and,

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

or again :

$$dF = F_{Pl}$$

and,

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

From the point of view of interpretation, there are no "physical plates" that could play a surface role in cosmology for the Casimir effect. On the other hand, it seems acceptable to assume that  $1/dS$  plays the role of energy, of dimension  $[L^{-2}]$ , in cosmology or in quantum field theory. This change in "role" would be comparable to that made with the cosmological constant  $\Lambda$  initially intended to account for a static universe, and eventually, by changing the side of the equation, accounted for the accelerated expansion of the universe.

### Conclusion

We have empirically determined the energy density of the cosmological constant with Planck units. We proposed a new application of Casimir effect with the cosmological constant and the Zero Point Energy of vacuum.

### References :

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