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Casimir Energy and the Electromagnetic Field

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The only true invariants are dimensionless numbers ("charge"). Their possibility of stable and non-homogeneous behavior can only be expressed by a periodic function (injection locked to the same frequency). This causes interference effects and phase retardation. The sign of energy (charge) is given by the sign of frequency (time, wavenumber). Thanks to local asymmetry [1] our signs only correspond to the koinomatter (and **the weak** asymmetry).

An analogy (equivalence) of the Casimir energy regularization (a difference of continuous and a quantized function) and a difference of the relativistic energy of the (interfering) particle bounded in a potential well (infinite for a conductor with infinite permittivity) and a (non-quantized) free particle is evident.

The repulsive Casimir energy of a field in a perfectly conducting spherical shell is given by the relation

$$E_C = \left(\frac{3}{64} - 9 \cdot \frac{\pi^2 - 8}{32768} + \cdots \right) \frac{hc}{2\pi a} \approx 0.007378 \frac{hc}{a}$$

where a is a radius and h and c are conventional constants defined by the units used (a more precise solution ≈ 0.00734925 with a difference of 0.71% of the fine structure constant could be - in the case of the electron itself - radiatively self-corrected to better match in value). In the case of a hollow conducting cube (with a side of length $2a$), this factor is approximately 0.091657427016/2/2π ≈ 0.007294. These factors are similar for different geometries (with the same volume-to-surface ratio because $(2a)^3/6(2a)^2 = (4/3)\pi a^3/4\pi a^2 = a/3$ and also for a closed finite cylinder $2\pi a^3/2\pi a(a+2a)$) and thus probably, we can get the fine structure constant exactly when this factor is appropriately corrected and in a correct geometry (with a value between these geometries - a sphere inside a cube).

For the dimensions of the Bohr perimeter and two "polarizations"

$$a = 2 \cdot 2\pi \cdot a_B = \frac{2h}{\alpha mc}$$

the repulsive Casimir energy equals to 13.6eV. This is close to the hydrogen ground state (kinetic) energy

$$E = \frac{mc^2}{2} \alpha^2 \approx 13.6 eV$$

because

$$E_{CB} = \left(\frac{3}{64} - 9 \cdot \frac{\pi^2 - 8}{32768} + \cdots \right) \frac{1}{2\pi} \frac{mc^2\alpha}{2} \approx \frac{mc^2}{2} \alpha \frac{3}{128\pi}$$

The electron interference at the lowest orbit can be interpreted as the repulsive Casimir force keeping it away from the nucleus. The Casimir electrostatic potential is given by

$$V = E_{CB} \frac{a_B}{r}$$

which corresponds to the classical electrostatic potential. This potential in classical electrodynamics can explain stable atomic levels (as interference) [2]. And also additional QED corrections of atomic (hydrogen) states (such as the Lamb shift) correspond to the Casimir effect [3].

If **the electromagnetic interaction** can be expressed as “a number interaction”, all atomic levels are given by numbers (as the fine structure constant) only. The strongest dependency (constant with a distance) is a value itself (and corresponds to **the strong interaction**). Its retarded interaction (potential) is the Casimir energy ($1/r$).

Although **the gravitational interaction** origin is not clear, we can choose one of suggested possibilities below.

Light represents a change of angular momentum and its forces (directions of particle acceleration, scattering, ionization) are associated with the electromagnetic field (polarization) direction. And thus a radiation pressure is not given by electromagnetic field momentum. And more, this force is proportional to the number of dipoles (mass, volume) and not simply to surface (as Le Sage's theory).
In this electric dipole theory there is also no screening problem. If a body is placed between the source and target bodies then a dipole from the source induce changes in it (now the source) also by dipole interaction and this is transferred to the target with the same distance dependency.
The total induced electric dipole moment P field of a sphere (with radius R and relative permittivity ε_r) in the electromagnetic field E is given by

$$\frac{P}{3\varepsilon_0} = \frac{4}{3}\pi R^3 E \frac{\varepsilon_r - 1}{\varepsilon_r + 2} = VEf$$

The factor f equals 1 for conductors (and free charges as they are on microscopic level) and $f>0.25$ for most of the solid dielectrics ($\varepsilon_r>2$).

If we define (for example,) the strong interaction value as a $4/\alpha$ multiple of electromagnetic interaction, we can find that interaction, the ratio R from [4], is close to 8.06E-37 and for gravitation-to-strong interaction ratio, the approximate equation is given by

$$R_S \approx \left(\frac{\alpha}{4\pi} \right)^{12} \approx 1.47 \cdot 10^{-39}$$

It can be interpreted as a retarded van der Waals potential (gravitation sticking). The 1/r dependency can be explained as an analogy to the highest time derivate from microscopic position/motion generating 1/r term in the relativistic Liénard-Wiechert retarded potentials. Thus the amplitude of this term is weaker by this gravitation-to-strong interaction ratio.

The van der Walls potential is a relativistic interaction of neutral bodies with displaced charges with opposite polarity (as electrons and protons are). The energy sum

$$\left(\sum e - Ac\sum\frac{1}{r}\right)^2 = \left(\sum pc\right)^2 + \left(\sum m_0 c^2\right)^2 \quad \text{or} \quad \left(\frac{E}{c} - A\sum\frac{1}{r}\right)^2 = P^2 + \left(M_0 c\right)^2$$

in the case of vector dipole moment separations l_1 and l_2 with a mutual distance $R \gg l_1, l_2$ can be rewritten as

$$P^2 + \left(M_0 c\right)^2 = \left(\frac{E}{c} - A\frac{2l_1 l_2}{R^3}\right)^2 = \left(\left(\frac{E}{c}\right)^2 - 2\frac{E}{c}A\frac{2l_1 l_2}{R^3} + \left(A\frac{2l_1 l_2}{R^3}\right)^2\right)$$

The term $1/R^3$ vanishes with random dipole orientation averaging (analogously as the first order Doppler shift) and thus a classical energy form is

$$E - M_0 c^2 \approx \frac{P^2}{2M_0} - \frac{\left(2Acl_1 l_2\right)^2}{2M_0}\frac{1}{R^6}$$

However the potential sum of moving dipoles is

$$-A\frac{2\beta_1\beta_2}{R - \beta R}$$

where A corresponds to an electromagnetic interaction strength α, β_1 to the negative charge (electron) velocity ratio α and β_2 to the positive charge (proton) velocity ratio $\alpha m_e/m_p$. This gives for random orientation, a non-averaged out term

$$\left(A\frac{2\beta_1\beta_2}{R - \beta R}\right)^2 \approx 4\alpha^6\left(\frac{m_e}{m_p}\right)^2\frac{1}{R^2}$$

The radiated energy is given for acceleration with factor $\beta \rightarrow \beta^2$, additional projection and dependency 1/R.

$$\left(4\alpha^6\left(\frac{m_e}{m_p}\right)^2\right)^2\frac{2\pi\alpha}{R} = 2\pi\alpha\left(2\alpha^3\frac{m_e}{m_p}\right)^4\frac{1}{R} = 1.47\cdot 10^{-39}\frac{1}{R}$$

where the value corresponds to the gravitation-to-strong interaction ratio.

Now we can suppose (without proving the previous relations) that all (fundamental) physical constants are dimensional and thus conventional [5] or they are dimensionless constants and thus conventional (empirical, local) or mathematical. It was shown that all interaction effects can be linked (an equivalent source). And more, we can conclude that there is **no physical reality** but only a mathematical one (and only quantitative (numerical) effects can be proved).

An additional note:

The Hawking radiation temperature

$$T_H = \frac{\hbar c^3}{8\pi GMk}$$

should be twice in value because the Unruh radiation temperature with acceleration

$$a = \frac{c^2}{r_S} = \frac{c^4}{2GM} \qquad \text{gives} \qquad T = \frac{\hbar}{2\pi ck} a = \frac{\hbar c^3}{4\pi GMk}$$

The radiated power per sphere with the Schwarzschild radius from an electron-degenerate matter body with mass at the Chandrasekhar limit $M=1.44*M_{SUN}=2.86E30\ kg$ is then

$$P = A\sigma T^4 = \frac{hc^6}{1920\pi^2 G^2 M^2} = 6.95 \cdot 10^{-28} W$$

This power is very close to the power of the Unruh radiation of molecular hydrogen [4] and corresponding acceleration of the Universe with an age of about 13.7 Gy.

[1] P. Křen: The Asymmetry is Our World, 2009, http://wbabin.net/science/kren7.pdf

[2] P. Křen: The Source, the Field or the Metric?, 2006, http://wbabin.net/science/kren3.pdf

[3] A. Rosencwaig: A Casimir approach for radiative self-energy, http://arxiv.org/ftp/hep-th/papers/0606/0606217.pdf

[4] P. Křen: The Cosmic Microwave Background Radiation as the Unruh Effect Radiation of Molecular Hydrogen, 2008-2009, http://wbabin.net/science/kren8.pdf

[5] P. Křen: Notes on Relativity, 2005, http://wbabin.net/science/kren.pdf