Getting, From the Vacuum, a Hidden Secret

Roald C Maximo

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Retired radio engineer; formerly Director of
Research and Development by
Control S/A Radio Communications
in São Paulo, Brazil contact:: rc-maximo@uol.com.br

Abstract

It seems to me already sufficiently proven that light is a wave phenomenon. Only the excuse that a wave phenomenon could not propagate through a vacuum (through nothing) would justify the ballistic interpretation of the phenomenon. However, with the publication of "A Dynamic Theory of the Electromagnetic Field", as early as 1865, Maxwell made it established that electric and magnetic fields travel through space like waves moving at the speed of light. Maxwell proposed that light is a wave in the same medium that is the cause of electric and magnetic phenomena. Later on, Heinrich Rudolf Hertz (February 22 1857 1 January 1894) a German physicist who first proved conclusively the existence of the electromagnetic waves as theorized by the electromagnetic theory of James Clerk Maxwell. Hertz proved the theory through engineering instruments to transmit and receive radio pulses using experimental procedures to exclude the possibility of all other hypothetical wireless transmission means. That said, it is clear that the so-called vacuum has, necessarily, some physical attributes essential for these phenomena to occur. Two of these attributes, Permittivity and Permeability will be be the main characters in this script and, once rewritten in a fundamental form, will expose the the energy therein contained

Key words: Casimir, vacuum energy, most fundamental units

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The vacuum energy, as predicted by quantum mechanics, was initially regarded by the scientific community as one more quantum extravagance. However, the universal vacuum as a means of propagation of light, if taken as an absolute vacuum can only make sense if we go back by seeing light as a ballistic phenomenon, a thing that, oddly enough, is still is a matter of dispute among some physicists

Salvation came with the entrance of the Dutch theoretical physicist Hendrik Casimir who performed a very well designed and now widely known experiment, that doesn't fit here to be described again, and could thereby prove that the vacuum exerts a kind of pressure and must, therefore, necessarily contain the quantum predicted energy. Casimir arrived at a mathematical formula, now quite widespread among the pertinent literature that, derived from he's experimental data, describes pretty well the results thus obtained. However, this does not close the issue because the riddle doesn't end here. It should be possible, from what is actually known about the vacuum, to extract, hence directly, this information. What is known, however, of the few physical properties of the vacuum comes down just to it's electromagnetic permittivity and permeability and, if some place remain to look for it, the energy is to be sought right as a component inside of those attributes.

The now well known and wide spread model based Casimir formula reads

$$E_{cas} = \frac{-h \cdot c \cdot \pi^2}{720} \cdot \frac{Ar}{d^3} \qquad (1)$$

where

Ar = area of each plane metal sheet d = distance separating the metal sheets

h = Planck's constant **J** / **Hz** **c** = velocity of light **m** / **s**

if we chose those dimensions to form a perfect cubic enclosure with, say, two arbitrary one square meter metal sheets separated by a distance of one meter , we can conveniently write the above equation as

$$E_{cas} = \frac{-h \cdot c \cdot \pi^2}{720 \cdot m} \qquad (1a) \qquad \text{giving} \qquad E_{cas} = 2.722977 \cdot 10^{-27} \cdot J$$

but as said above we want the vacuum to show up its energy content and for that purpose I thought it appropriate to strip both those traditional equations for ε_0 and μ_0 from their formal dresses and and try to put them in a more fundamental aspect. The formulas that quantify the permeability μ_0 and permittivity ε_0 of the vacuum presented until today in all textbooks are an assemblage of electromagnetic units, each consisting of other more fundamental physical units. To rebuild these equations in their most synthetic form I had to rummage at considerable length among CODATA tables, compose and recompose values until finally being able to assemble ε_0 and μ_0 in its most fundamental units. The new expressions here presented seem to me, unless mistaken, unprecedented since, in all of my 66 years of career as a radio engineer, I never stumbled on something even remotely similar. If, perchance, anyone knows of another source I'd appreciate it.

The pertinent fundamental units applied are

$e = 1.6021766 \times 10^{-19}\ C$	elementary charge (electron charge)
$h = 6.626070 \times 10^{-34}\ \frac{J}{Hz}$	Planck's constant
$\alpha = 7.2973525 \times 10^{-3}$	fine structure constant
$c = 2.99792458 \times 10^{8}\ \frac{m}{s}$	velocity of Light

$$\varepsilon_0 = 8.854188 \times 10^{-12}\ \frac{A^2 \cdot s^4}{m^3 \cdot kg} \qquad (2) \qquad \text{write it as} \qquad \varepsilon_0 = \frac{e^2}{2 \cdot h \cdot \alpha \cdot c} \qquad (2a)$$

$$\mu_0 = 1.256637\times 10^{-6}\,\frac{m\cdot kg}{A^2\cdot s^2} \qquad (3)$$ write it as $$\mu_0 = \frac{2\cdot\alpha\cdot h}{c\cdot e^2} \qquad (3a)$$

Check :

$$\frac{e^2}{2\cdot h\cdot\alpha\cdot c} = 8.854188\times 10^{-12}\,\frac{A^2\cdot s^4}{m^3\cdot kg} \qquad \frac{2\cdot\alpha\cdot h}{c\cdot e^2} = 1.256637\times 10^{-6}\,\frac{m\cdot kg}{A^2\cdot s^2}$$

This being firmly established, we can move on to arrive at our goal in two simple steps

$$\frac{e^2}{2\cdot h\cdot\alpha\cdot c}\cdot m = 8.854\times 10^{-12}\,F \qquad (4)$$ vacuum capacitance, Farads

We know from electrodynamics that the energy E contained in a capacitor obeys the relation

$$E = \frac{C^2}{F} \qquad (5)$$

Energy, **Joules**, equals the ratio of the charge C in **Coulombs** squared to the capacitance in **Farads.** So, let's take the above space (vacuum) capacitance **(4)** and apply the energy formula (5) to get

$$\frac{C^2}{F} = J \qquad \frac{e^2}{\varepsilon_0\cdot m} = \frac{2\cdot h\cdot\alpha\cdot c}{m} \qquad E_{vac} = \frac{2\cdot h\cdot\alpha\cdot c}{m} \qquad (6)$$

that gives for **m** = 1m $$E_{vac} = 2.8991590\times 10^{-27}\,J$$

the results above may allow us to adopt the following relations:

$$\varepsilon_0 = \frac{e^2}{E_{vac}\cdot m} \qquad (7) \quad \rightarrow \quad \frac{e^2}{E_{vac}\cdot m} = 8.854187913072584\times 10^{-12}\cdot\frac{F}{m}$$

$$\mu_0 = E_{vac}\cdot\frac{m}{c^2\cdot e^2} \qquad (8) \quad \rightarrow \quad E_{vac}\cdot\frac{m}{c^2\cdot e^2} = 1.256637048\times 10^{-6}\cdot\frac{H}{m}$$

$$Z_0 = E_{vac}\cdot\frac{m}{c\cdot e^2} \qquad (9) \quad \rightarrow \quad E_{vac}\cdot\frac{m}{c\cdot e^2} = 376.7303\,\Omega$$

What immediately calls attention is the somewhat similar aspect of equations (1a) and (6) and, taking into account that E_{cas} is a model derived equation based on observed experimental results, the calculations results are amazingly almost identical The minus sign in the Casimir equation is just a convention adopted to distinguish the vacuum energy from thermal and gravitational energy.

make the distance **d** any value, say $d = 1 \cdot \mu m$

$$E_{cas} = \frac{-h \cdot c \cdot \pi^2}{720 \cdot d} \qquad E_{cas} = -2.7229770 \times 10^{-21}\ J$$

$$E_{vac} = \frac{2 \cdot h \cdot \alpha \cdot c}{d} \qquad E_{vac} = 2.8991590 \cdot 10^{-21} \cdot J$$

The method employed to reach at the Casimir equation is a bit tortuous and was ably demonstrated by Trang T. Nguyen in his paper "*Casimir Effect and Vacuum Fluctuations*" (*) There must, however, have been some hidden glitch in that reasoning to account for the very slight difference of 6% here observed
It is clear that the energy equation E_{vac} , as here derived, must be the exact one since it was obtained as a reply by questioning directly the responsible entity, i.e. the vacuum itself, so it is that it doesn't come as a surprise when we observe that

$$\frac{\pi^2}{720} = (2 \cdot \alpha) \cdot 0.939 \qquad \frac{\pi^2}{720} \approx 2 \cdot \alpha$$

and if we substitute (**2α**) in place of (**π squared /720**), in the $\mathbf{E_{cas}}$ equation, both equations result exactly the same

(*) Casimir Effect and Vacuum Fluctuations
Trang T, Nguyen
Department of Physics and Astronomy
Ohio University