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Casimir Effect: a new interpretation

12/05/2006

1 Introduction

[1] That’s the way the physicist Marcello Piccolo describes this interesting phenomenon.

What is Casimir’s effect ? Who was him ? What is point zero energy ?

The Casimir effect was postulated in 1948 by the Dutch physicist Hendrick Casimir **and it can nowadays be considered one of the one of the few macroscopic effects of the quantum mechanics**. The phenomenology of the effect is simple: between two conductor plates NOT electrically charged (that for simplicity we will consider plain) leaned out a strength attraction is practiced: such strength cannot be explained with any classic phenomenon. The explanation of the phenomenon is instead not so simple: it has to do with the way according to which the void in the quantum mechanics is defined.

In the classical physics a region of space in which particles or fields are not present is defined as empty; in quantum physics, because of the principle of indetermination it is impossible to guarantee the complete absence of particles and/or fields in a region of the space: the void cannot be considered a zero-energy state because of the quantistic fluctuations behaving the creation and destruction of virtual particles that, in addiction, they live weary of brief time, but finite.

Since analogous phenomenons in the experience and in the every day life don't exist we can try to imagine analogies that, because of some things, they will not be rigorous in the description of the phenomenon in matter.

Let's imagine the quantistic void is a state in which some little balls are continually formed and disappeared; to fix our ideas let's think of something as a bead of soap (but supposed to be rigid) that it is born and after a certain time it bursts. Let's suppose besides that the more the ray of the little balls is little the more heavy the balls are.

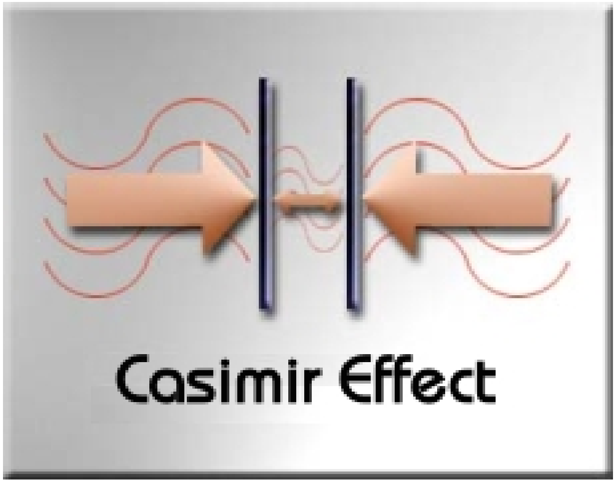
If we imagine to have a solid surface in any region of space (full of these little balls) to every fixed instant of time a certain number of little balls will bump the solid surface, originating from the right and another number of little balls will bump it originating from the left: for reasons of symmetry the two numbers will have to be average equal and therefore no strength will be practiced on the plate. If now we put two plates the one leaned out to the other, it will happen that on the two external faces of the surfaces the phenomenon of the bump of the little balls will be analogous to what we have described before; as it regards the inside faces now we have to keep in mind we cannot have little balls having a diameter greater than the distance to which the two plates have been positioned. In this case the equilibrium among the bumps on the two faces of the plates is altered: the number of bumps from the external part of BOTH THE TWO plates is greater than the corresponding number of bumps from the inside part. Therefore things go as if around the two plates a strength that extends to approach them would act and the more bigger is the effect expected the less is the distance among the plates in examination because the little balls have been supposed to be heavier. It's still to be well underlined that the introduced analogy is well afar from being rigorous and it must be seen as a way of illustrating a phenomenon complex enough having no analogous in the macroscopic world in which we live.

Now let’s try to give a quantitative value to the effect. The module of the strength attraction among the plates depends on the surface of the plates and from their distance according to the formula:

$$F = \pi \frac{hC}{480\, d^4} S \tag{1.1}$$

where h is Planck's c is the speed of light d is the distance among the two plates and S is their surface. The strength, as previously specified, is of attractive type; the two plates extend to get closer. The effect of which above is extremely small.

The recent experimental verifications [2] have found some experimental values in accord with those theoretical in about the 15%.
This effect is synthetically represented by the following figure [3]



This effect has also allowed a lot of and strong speculations brought in articles like **Casimir Effect and antigravity** of M. Nardelli [4] or **The engineering of the wormhole** of John Gribbin [5].

In conclusion, if two conductor plates, at the same potential, are sufficiently approached, a strength manifests that currently it comes to be attributed to quantistic fluctuations of energy that, thanks to the principle of indetermination by Heisenberg, it cannot be null. And this is one of the few macroscopic effects, if it's not the only one, of the actual quantistic mechanics. From here even its big importance for technological applications of avant-garde.

2 The new solution

In the works of the author of this article [6], manifold macroscopic ownerships of the matter have been shown like the elasticity module, the speed of sound in it, the coefficient of thermal expansion etc. they are all greatnesses that can be deduced by simple and unpublished formulas in which the electron charge appears, the inter-atomic distance and the mass of the atoms composing the matter in examination.

Even taking as base of departure the simplest crystalline structure existing in nature and that is the common crystal of salt Na^+Cl^- the following formulas have been written [6] (c.g.s. system).

$$v = \sqrt{\frac{2e^2}{m\psi}} \tag{2.1}$$

The gives the speed of sound in the matter and from it the same values that it furnishes the known formula by Newton are obtained

$$v = \sqrt{\frac{E_Y}{\rho}}, \tag{2.2}$$

where E_Y is Young's elasticity module of the matter in examination and ρ is its density. The fact that the (2.1) directly gives comparable values with those given from the (2.2) it is justifiable kept account that from the (2.1) it comes down the (2.2). In fact it is had

$$v=\sqrt{\frac{2e^2}{m\psi}}=\sqrt{\frac{\frac{2e^2}{\psi^4}}{\frac{m}{\psi^3}}}=\sqrt{\frac{E_Y}{\rho}} \tag{2.3}$$

and therefore it is seen that the elasticity module, currently deducible only from laboratory tests, it comes to be given by the unpublished theoretical relationship

$$E_Y=2\frac{e^2}{\psi^4} \tag{2.4}$$

while density is notoriously given by

$$\rho=\frac{m}{\psi^3} \tag{2.5}$$

kept account that it has been indicated by ψ the distance among an atom and another and that, when the matter in examination is composed from atoms having different masses m comes to represent the reduced mass. For the easy deduction of the (2.1) it is postponed to the article [6].

The fact that the matter is co-existed for electromagnetic bonds, over that for a purely intuitive fact, it is shown in an incontestable way by the (2.3) because it's easy to recognize that it can be written

$$v=\sqrt{\frac{\frac{2e^2}{\psi^4}}{\frac{m}{\psi^3}}}=\frac{\frac{\sqrt{2e^2}}{\psi^2}}{\frac{\sqrt{m\psi}}{\psi^2}}=\frac{electric\ field}{magnetic\ \ field}. \tag{2.6}$$

Besides It can shown that these equations [6], even if deduced departing from the simple crystalline structure of kitchen salt, they always give values of the same greatness order of the data of experimental character for the most disparate materials, provided that homogeneous, and they are valid enough for any state of the matter and therefore even the gases. It's evident that the number 2 appearing to numerator of the (2.4) will vary according to the structure more carefully studied. After said this, let's now consider the crystalline structure given in figure 1.

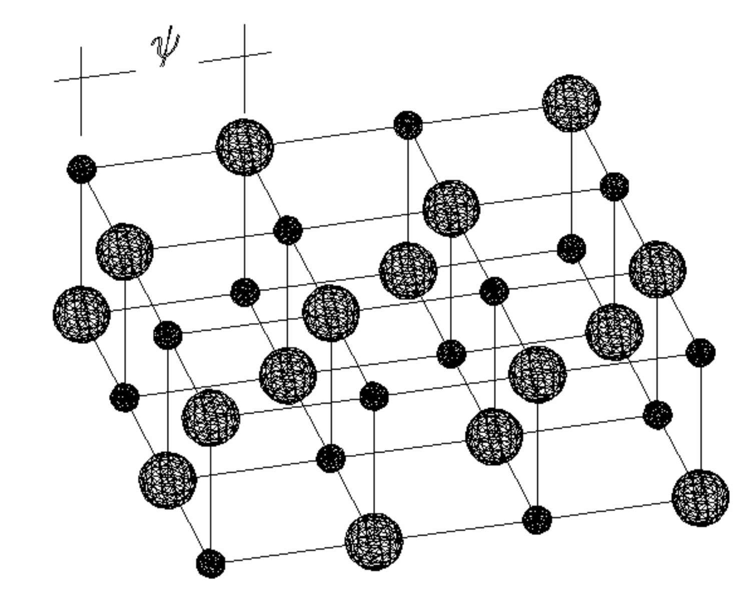


Fig. 1

Let's see what happens if we apply on the faces of left and right two equal and contrary strengths [6]. A single ion acts on a surface equal to ψ^2 and therefore we have to apply a pressure equal to

$$\frac{F}{A} = 2\frac{e^2}{\psi^2}\frac{1}{\psi^2} = 2\frac{e^2}{\psi^4} \tag{2.7}$$

counterbalancing the electromagnetic strength that arouses itself inside the crystal. From this it follows that applied strength is equal to

$$F = 2\frac{e^2}{\psi^4}A. \tag{2.8}$$

Now let's place side by side to the crystal of figure 1 an identical crystal as it is deduced by the figure 2, in such way that the two overlooking faces of the two crystals are parallel and are to a distance equal to d. With this let's go realizing two plates of Casimir that are faced.

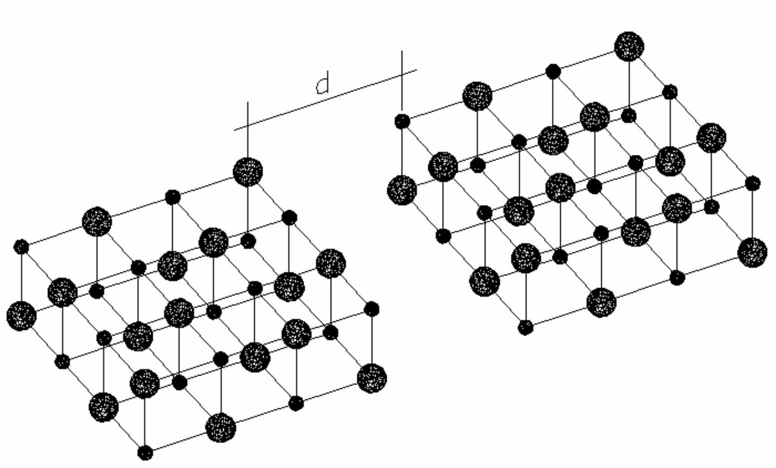


Fig. 2

The two crystals will evidently be attracted among them by a strength approximately given from

$$F = 2\frac{e^2}{d^2}\frac{1}{\psi^2}A. \tag{2.9}$$

Minding the known bond

$$2\pi e^2 137 = hC \tag{2.10}$$

the (2.9) becomes

$$F = 2\frac{e^2}{d^2}\frac{1}{\psi^2}A = 2\frac{hC}{2\pi 137}\frac{1}{d^2\psi^2} = 2\frac{hC}{860.79}\frac{1}{d^2\psi^2} = \frac{hC}{430.95}\frac{1}{d^2\psi^2}. \tag{2.11}$$

If the distance among the two faces of the two crystals is of the same order of greatness of the inter-atomic distance it is evidently had

$$\boxed{F = \frac{hC}{430.95}\frac{1}{d^4}} \tag{2.12}$$

that is directly comparable with the one deduced by Casimir in the hypothesis of fluctuations in the void of point zero

$$F = \frac{\pi hC}{480}\frac{1}{d^4} \tag{2.13}$$

but it is evident that the (2.11) is more general than this last one because it foresees different behaviors according to the used material and of the existing distance among the two plates.

On the other hand the reliability of the (2.11), at least to the actual state, it's sustained by the fact that the experimental elasticity module of $NaCl$ is equal to

$$E_Y = 0.5\times 10^{12}\,[dyne/cm^2] \tag{2.14}$$

and that theoretical one furnished by the (2.4) is given by

$$E_Y = 2\frac{\left(4.8\times 10^{-10}\right)^2}{\left(2.85\times 10^{-8}\right)^4} = 0.6\times 10^{12}[dyne/cm^2]. \tag{2.15}$$

In base to what now noticed it's immediately seen that the Casimir effect is univocally connectable to the qualitative effect of Majorana (Volta effect) [7] and it finds in the (2.11) one clear generalization of it.

3 Conclusions

The forecast of Casimir implies, in the most inclined void, the existence of a not null energy.

The experiment with which such theoretical forecast is verified considers this hypothetical void contained among two metallic plates, set to a distance among them of the same order of greatness of the existing distances among the atoms composing the plates themselves.

Therefore it is implied that the existing electromagnetic demonstrations among the atoms composing the two plates are completely void on the surface of the plates and beyond them, denying in toto the voltaic effect put in evidence by the experience of Majorana [7] as well as those, much more evident, for capillarity.

On the other hand the same theoretical relationship by Casimir

$$\boxed{F = \pi \frac{hC}{480\, d^4} S} \tag{3.1}$$

minding the known relation

$$2\pi e^2 137 = hC \tag{3.2}$$

becomes

$$F = 5.6 \frac{e^2}{d^4} \tag{3.3}$$

in which the undeniable existence of an electric field is clearly seen "*in the void*" existing *among the faces of the two plates and therefore in the matter*.

There is therefore an incurable conflict among the deductions and theoretical implications of the Casimir effect on one hand, the experience of Majorana [7] and the effects of the capillarity, from the other.

This conflict can end only by admitting that in the void among the two plates a residual electric field to the outside of the matter itself going to occupy such void exists.

On the other hand, if it is admitted that in the said void there's an energy of the type

$$E = \frac{1}{2} h\nu = \frac{1}{2} h \frac{C}{\lambda} \tag{3.4}$$

it's also had, by considering the (3.2), this energy can be written

$$E = \frac{1}{2}\frac{hC}{\lambda} = \frac{1}{2}\frac{2\pi 137 e^2}{\lambda}. \qquad (3.5)$$

If [7] is posed

$$\lambda = 2\pi 137\, d \qquad (3.6)$$

it's had that this energy exists in the void, confined of the matter, it can be posed, more directly and easly, even equal

$$E = \frac{1}{2}\frac{e^2}{d}. \qquad (3.7)$$

The equation (3.6) allows a re-reading of Plank's work [9].

Bibliography

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