Permittivity reveals the World behind the Quantum Vacuum

Rev. Apr. 25, 07

John C. Polasek[1]

(We found the vacuum to be "backed" by a new solid region, "pair-space". Its remarkable qualities, which are derived below, are summarized in Table 1. Eq. (14) defines ε_0 in terms of those qualities). In physics the vacuum of space is considered to carry gravity and electromagnetic transmissions despite that it is a pure void. Yet, through its proven permittivity, it can store electric energy. This mandates some form of charge density, inevitably a cloud of "neutral" electron-positron pairs. Our analysis finds pairs to be co-located, uniformly spaced at $\Lambda = 3.541 \times 10^{-14}$ m, having among other properties, a transmission velocity equal to c. (See Table 1). This solid region is accessible only electrically. Its extreme mass density (5 million times that of iron), demands a separate, extremely potent space *underlying* the vacuum, that I call pair-space. It would satisfy Heisenberg's quest for a region "in which physics would be different" to avoid renormalization. It seems compelling that pair-space is a calibrated version of the so-called quantum vacuum, which however, has no defined properties. Similarly Dirac's sea of electrons was a purely mathematical construct with anomalous specifications.

KEY WORDS: Permittivity, S.I., sea of electrons, quantum vacuum, electron-positron pairs, pair-production, fine-structure constant

1. INTRODUCTION

For centuries we have trusted the vacuum to carry gravity and radio waves over vast distances even though vacuum was known to be a void. It appeared possible to learn its secret by analyzing its polarizability ε_0 Farad/meter and its *permeability* μ_0 Henry/meter, which are fundamental SI units, but were discarded in cgs units. I will show that permittivity acts a region that is densely packed with electron positron pairs that respond only to electric fields and is an exact *dual* to our vacuum. It is the concrete realization of the widely accepted but nebulous quantum vacuum. Dirac in 1927 proposed a sea of negative energy electrons, superficially resembling pair-space but which was an ad hoc extrapolation from the total energy equation . Permittivity is the conduit for the Maxwell's displacement current, a concept that is vigorously debated and denied in many quarters, but which will find support here.

2. VACUUM CAPACITOR PROVIDES THE WINDOW.

An example in direct support of Maxwell's displacement current dD/dt is the pictured teacup-sized broadcast capacitor rated at 150 amperes of high frequency current. Vacuum is essentially loss-free (aside from support structure).

Fixed Vacuum Capacitor
From Meivac

Capacitance range : 6 - 1750 pF
Voltage range : **5 - 35 kVp**
Current range : **up to 150 A. (rms)**
(Ex: 10kVp x 100A = 1 megawatt)

3. CAPACITOR EQUATIONS AND PERMITTIVITY

A parallel plate vacuum capacitor has a capacitance in farads (coulombs/volt) given by:

$$C = \varepsilon_0 A / g \ \text{coul/volt} = \textit{farads} \ \text{where}$$
$$\varepsilon_0 = 8.854x10^{-12} \ \textit{farad/meter} \qquad (1)$$
$$A = \textit{area}, \ g = \textit{gap} \ \text{(meters)}$$

When we connect a battery V_0 with internal resistance R to a capacitor, the initial current inrush is $I_0 = V_0/R$ quickly subsiding to zero as its voltage rises to satisfy Eq. (2a).

[1] Orlando FL jpolasek@cfl.rr.com.
Submitted to Annales de la Fondation Louis de Broglie.

Some of the governing equations are:

$$I = I_0 \cdot e^{-t/RC} \qquad V(t) = V_0 - I_0 \cdot R \cdot e^{-t/RC}$$
$$Q = \int idt = CV \quad \text{coulombs} \qquad V = Q/C \tag{2}$$
$$D = Q/A = \text{CV/A} = \varepsilon_0 \text{V/g} = \varepsilon_0 \text{E} \quad \text{coulombs/m}^2$$

The constitutive equation $D = \varepsilon_0 E$ (see also Eq. (16)) is part of Eq. (2b). It calculates charge/area D that is obviously on the plates but more importantly, is a point function that is present *throughout the gap g* along with E. The dielectric stores the energy, while the plates are merely contacts carying E to every part of the surface of the dielectric (vacuum or solid).

$$\text{Capacitor energy} = \tfrac{1}{2}\, CV^2 = \tfrac{1}{2}\, ED = \tfrac{1}{2}\, \varepsilon_0 E^2 \tag{3}$$

If D and energy are to be present in the gap, then some form of charge density ρ must exist. Maxwell's divergence equation offers a way to get this.

4. MAXWELL'S DIVERGENCE

Maxwell's inspiration was to introduce displacement current dD/dt in vacuum. We can use Maxwell's equations to generate D in a vacuum as in Eq.(2) if we postulate existence of a cloud of virtual vacuum charges. Let there be equal numbers of positive and negative charges, to achieve neutrality. Integrating Eq. (4a), from x = 0 to δ yields $D = D_x = \rho\delta$ as in Eq. (4b):

$$\nabla \cdot D = \rho = dD/dx \quad \text{divergence equation}$$
$$\therefore \int_0^{\delta} \frac{dD}{dx}\, dx = D_x = D = \rho\delta \ \text{coul/m}^2 \ \text{in the gap} \tag{4}$$
$$\therefore Q_{disp} = D \cdot A = \rho \cdot (A \cdot \delta) = \rho \cdot \Delta V \ \text{coul}$$

Eq. (4b) shows that a displacement of δ meters in the charge cloud ρ would generate D throughout the gap. Figs.1 and Eq. (4c) show how even Q itself can be present in each differential volume $\Delta V = A\delta$. In Fig. 1 the entire cloud is shown shifted by δ with the protruding volume $A\delta$ containing displacement charge Q.

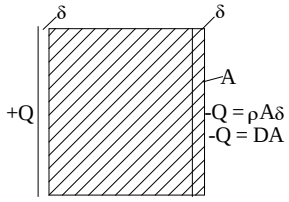

Fig. 1 showing δ-shifted pairs making displacement D

The protrusion in Fig. 1 is figurative only, as these "excess" electrons have already made their way down the wire. After disconnection, the plates are left neutral and the dielectric remains under stress since there is no path for reverse current. The voltage remains, sustained now by the displaced polarized charges. The charges that were initially the sink, now become the source.

5. HOW CAN THERE BE CHARGE CLOUD ρ WHEN THE VACUUM IS A VOID?

We model ρ as electron-positron pairs, each pair in a cubic cell of size Λ. The pair density is $\rho = \rho_{ep} = 2e_e/\Lambda^3$, with Λ to be determined.

6. MAKING A CAPACITOR WITHIN A CAPACITOR

As a start, we can configure the cell as a capacitor by figuratively metallizing opposite faces of the cell, and using Eq. (1a).

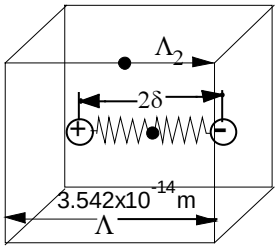

Fig. 2 Spring-restrained pair in Λ cell

Fig. 2 shows the ep+ pair with each particle being centered by a linear spring (or equivalent) to support linear polarization. An applied voltage/field across the plates would deflect the charges equally and oppositely. Thus the capacitor energy would be stored in the "springs".

We have defined the cell as a special region *inside of which the normal inverse square law does not operate.* There is a striking resemblance to the strong force (confinement) present in nucleons, or action of a point mass inside a spherical gravitational mass ($g \propto r$).

7. FINDING THE CELL SIZE Λ

We still need to find the cell size Λ. The governing equations for our cell as a capacitor are:

$$\begin{aligned} &C = \varepsilon_0 \Lambda^2 / \Lambda = \varepsilon_0 \Lambda \\ &q = V_c \cdot C = V_c \varepsilon_0 \Lambda = 2e_e \quad \text{so that } V_c \text{ will force 2 electrons out} \\ &\therefore \Lambda = 2e_e / V_c \varepsilon_0 \quad \text{with } V_c \text{ still unknown} \end{aligned} \tag{5}$$

We require a value for V_c that would convert the "virtual" charges to real charges.

8. ANDERSON'S PAIR PRODUCTION COMES TO MIND

Our attempt to extrude an electron pair is strikingly parallel to Carl Anderson's 1932 discovery of pair production. He observed several examples of oppositely curving tracks pairs from a single point, driven by cosmic rays, which led to discovery of the positron and then of electron positron pairs.

Using Einstein's energy-mass equation for two electrons:

$$W = 2m_e c^2 = 1.022x10^6 \, electronvolts \tag{6}$$

suggests that we try a critical voltage $V_c = 1.022x10^6$ volts across the capacitor (a choice validated by later results). Substituting V_c into (5d) determines Λ:

$$\begin{aligned} &\text{Let } V_c = 1.022x10^6 \, volts \\ &\therefore \Lambda = 2e_e / V_c \varepsilon_0 = 3.542x10^{-14} \, meters \quad \text{from (5d)} \\ &\Lambda_2 = \Lambda / 2 = 1.771x10^{-14} \, meters \\ &\Lambda_2 \text{ equals the Compton Wavelength x FSC } \alpha: \\ &\Lambda_2 = \alpha \cdot \lambda_{cwl} = \alpha \, h / m_e c = 7.297x10^{-3} \cdot 2.427x10^{-12} \, m \\ &V_c e_e = 2m_e c^2 = 1.636x10^{-13} \, J \\ &\qquad \text{where } e_e = 1.602x10^{-19} \, coulombs \text{ and} \\ &\alpha = FSC = e_e^2 / 2hc\varepsilon_0 = 7.297x10^{-3} \text{ fine structure constant} \end{aligned} \tag{7}$$

9. Λ, A NEW FUNDAMENTAL CONSTANT

Accordingly, we find the "primal" cell size to be $\Lambda = 3.542x10^{-14}$ m. Each pair resides inside a cell of size Λ from which the charges cannot be expelled except by extreme electric fields exceeding $2.886x10^{19} Vm^{-1}$ as in Eq.(8a). Further, we identify $\Lambda_2 = \Lambda/2$ as the half-cell *range of motion* for each charge equal to the

Compton wavelength reduced by α as shown numerically in Eq. (7d) or as may be proved algebraically (with some labor)[2]. The finite value Λ avoids zeroes, eliminating the need for renormalization.

10. FORCES AND ENERGIES

By knowing Λ and V_c we can derive further properties of the vacuum. For example, it takes enormous field strength Eq. (8a), to extract a pair. The force F_{max} at partition is just over one pound Eq. (8b). The energy to extract an electron in Eq. (8c) is ½ mc^2. We show in [1] that an additional ½mc^2 is spent to launch the electron to the speed of light for a total of mc^2, in a completely new theory of the universe.

$$\begin{aligned} E_c &= V_c/\Lambda = 2.886x10^{19}\ volt/m \ \text{ critical field strength} \\ F_{\max} &= e_e E_c = 4.62 newton = 1.038 lbs \ \text{ to remove } e^- \\ W_e &= F_{avg}\cdot\Lambda_2 = m_e c^2/2 = 4.092x10^{-14}\ J \ \text{ per charge} \\ &= 1.022 MeV/4 \ \ electron\ volts \ \text{removal energy} \end{aligned} \tag{8}$$

It might seem possible to produce pairs with 1+ MeV X-rays tube but several references cited in [4], [5], indicate that elaborate efforts would be required. The TESLA XFEL for example [5] aims for $1.3x10^{18}$V/m (which is $2\pi\alpha V_c$) using a 20 GeV Linac working through a 4 km. tunnel with 37 GW peak power and $6x10^{18}$W/m^2, to be commissioned in the near future.

11. CHARGE AND MASS DENSITIES

In a typical case of 10^6V/m we see that δ is only 10^{-27} m or 10^{-14} part of its range, Λ_2:

$$\begin{aligned} \rho_{ep} &= 2e_e/\Lambda^3 = 7.2x10^{21}\ \text{coul/m}^3 \\ \text{Let}\quad E_{ex} &= 1000V/1mm = 10^6 V/m \\ \delta_{ex} &= E_{ex}\varepsilon_0/\rho_{ep} = 1.23x10^{-27}\ m \end{aligned} \tag{9}$$

The mass density exceeds that of iron by a factor of 5 million:

$$\begin{aligned} \rho_m &= 2m_e/\Lambda^3 = 4.104x10^{10}\ kg/m \\ \rho_m/\rho_{Fe} &= 5.260x10^6 \text{ or } 2/\alpha^3 \ \text{ times iron} \end{aligned} \tag{10}$$

12. DISCOVERY OF NEW SPACE: PAIR-SPACE

With such density this pair-space region must be not just the vacuum, but another space. The mechanical qualities of density and bulk modulus combine in Eq. (12). for a transmission velocity of c. Thus, pair-space appears to be a legitimate replacement for the failed concept of ether.

This region is only accessible by means of electric field polarization, and it exists as a dual to our vacuum universe, but scaled down by $\alpha \sim 1/137$.

13. A UNIQUE REGION FOR RENORMALIZATION: R_0 OR Λ_2

The fields of QED and QFT deal with singularity problems using renormalization. Heisenberg (1938) saw the problem and sought to find [3] a cutoff region, r_0, in which the physics "would be different". He tried to form a length from h, c and e_e, but the Compton wavelength (CWL) of the electron was too large, so he proposed a *proton* wavelength of $1.322x10^{-15}$ m. We suggest our region as satisfying both of his requirements, being smaller than CWL by the factor α Eq.(7d), and with *different physics* (linear vs inverse square) in its interior. Furthermore, our cutoff frequency in Eq. (11b) can be used at the "ultra-violet" end.

14. CUTOFF AND RECOMBINATION

Another quantity of interest in quantum theories is cutoff frequency. The powerful spring constant K inside the cell makes for a very high resonant frequency. Some pertinent values are:

---

[2] Multiply Eq.(7h) by $h/m_e c = \alpha * CWL$, insert Eq. (7f) and find it to equal Eq. (7a)/2 = Λ_2.

$$
\begin{aligned}
&K = F_{\max}/\Lambda_2 = 2.612x10^{14}\,N/m \quad \text{spring constant}\\
&\omega_0 = \sqrt{K/m_e} = 1.693x10^{22}\,rad/\sec \;\; \text{T/rad} = 5.91\text{x}10^{-23}\,s\\
&F_0 = 2.693x10^{21}\,cy/\sec \;\; \text{T/cycle} = 3.722\text{x}10^{-22}\,s\\
&\omega_0 \cdot \alpha = 1.235x10^{20}\,rad/\sec\\
&W = \alpha \cdot \omega_0 \cdot h = m_e c^2\,Joules\\
&\omega_0 \Lambda_2 = c
\end{aligned}
\qquad (11)
$$

It may be of interest to see that two different times of recombination from QED are quite similar to the time per cycle for F_0:

$$1)\ \Delta T = h/4\pi m_e \cdot c^2 = 6.443x10^{-22}\,s \;\; \text{QED}$$

2) from the following expression we get :

$$\text{hf} = \text{m}_e c^2 \;\; \text{T} = 1/\text{f} = 8.096x10^{-21}\,s$$

3) from our F_0 we have :

$$\text{T} = 1/\text{F}_0 = 3.722x10^{-22}\,s/cycle$$

These are times expected for the recombination of pairs that have been produced. This is a subject that merits further study, but so far, Espace theory does not involve quantum effects.

15. TRANSMISSION VELOCITY = C

Another remarkable property is that the transmission velocity is equal to c, as determined by ρ_m and bulk modulus Y as derived below (just as μ_0 and ε_0 determine c):

$$
\begin{aligned}
&Y = \frac{\partial P}{\partial x/\Lambda_2} = \frac{K\partial x/\Lambda^2}{\partial x/\Lambda_2} = \frac{K}{2\Lambda} = \frac{2m_e c^2}{\Lambda^3} = \rho_m c^2 = 3.688x10^{21}\,Nm^{-2}\\
&Vel = \sqrt{\frac{Y}{\rho_m}} = 2.9988x10^8\,ms^{-1} = \sqrt{\frac{1/\varepsilon_0}{\mu_0}} = c
\end{aligned}
\qquad (12).
$$

16. MAXWELL'S DISPLACEMENT CURRENT.

Typical polarizing deflections are extremely small ($\delta \sim 10^{-27}$ m). As the charging current I flows into the plates (13a), the pairs deflect against their springs by δ. (It is not possible to impose a voltage on a capacitor; voltage rises as charge accumulates). (Note the similarity to Maxwell's displacement current in (13b)). After charging, the current stops, so upon cutting the wire the polarized pairs would remain deflected, retaining the voltage difference, since there is no return path for a reverse relaxing current. E and D as well as the potential difference are still present, embodied in the deflection.

$$
\begin{aligned}
&I/A = dD/dt = dQA^{-1}/dt = \rho\, d\delta/dt\\
&\nabla x H = \partial D/\partial t + J
\end{aligned}
\qquad (13)
$$

We see that the capacitor's energy resides in the charges' restraining "springs".

17. THE REAL MEANING OF PERMITTIVITY

Detailed analysis mandates that vacuum polarizability ε_0 *must have* the 12 characteristics shown in Table 1. In [1], we have used the new fundamental constants, K and Λ to form eight different expressions for permittivity, of which four examples are:

$$(a)\frac{4\cdot e_e\cdot\rho_e}{K}=(b)\frac{e_e^{\,2}}{\Lambda m_e c^2}=(c)\frac{e_e^{\,2}}{2\alpha\cdot h\cdot c}\;=(d)\frac{2e_e}{\Lambda^2\cdot E_c}=\varepsilon_0=8.854x10^{-12}\,F/m$$

where (e) $\Lambda=2\alpha\lambda_{CWL}=2\alpha\, h/m_e c=4\pi r_{class}$ and $\rho_e=e_e/\Lambda^3$ total

Combine (a) and (b) to get $0.5K\Lambda^2=2m_e c^2$

energy equation (14)

In (a) clearly shows how ε_0 aids an electric field with double charge times double pair density countered by the spring constant K.

Table 1 Summary of Pairspace parameters

Quantity	Symbol	Dual Space value	QED
#1. Primal cell size = $2\alpha h/m_e c$	$\Lambda=2\Lambda_2$	$3.541\cdot10^{-14}\,m,\ \Lambda_2=\alpha\lambda_{CWL}$	0
#2. Spring stiffness	**K**	$2.612\cdot10^{14}\,N/m$	0
`1#3. Bulk Modulus: = K/2Λ	**Y**	$3.688\cdot10^{27}\,N/m^2\ (J/m^3)$	0
#4. Electron density	ρ_e	$3.608\cdot10^{21}\,coul/m^3$	0
#5. Mass density $\rho_m=2\rho_{me}$	$\rho_m,\ \rho_{me}$	$4.103*10^{10}$ kg/m^3	0
#6. Electron/iron mass ratio ρ_{me}/ρ_{Fe}	ρ_{me}/ρ_{Fe}	$2.6x10^6\ \ (=\alpha^{-3})$	0
#7. Transmission Velocity = c = $\sqrt{1/\mu_0\varepsilon_0}$	**c**	$\sqrt{Y/\rho_m}=2.998x10^8$ ms^{-1}	0
#8. Critical Volt. Gradient $E_c=V_c/\Lambda$	$\mathbf{E_{crit}}$	$2.886\cdot10^{19}\,Vm^{-1}$	0
#9. Energy density of pairspace (= ½ Y)	$\mathbf{W_D}$	$1.847\cdot10^{27}\ J/m^3=m_e c^2/\Lambda^3$	0
#10. Self-resonant K/m_e radian frequency	ω_0	$\omega_0=1.693\cdot10^{22}\,rad/s$	0
#11. Resonant wave length	λ_{res}	$\lambda_{pl}=1.1132\cdot10^{-13}=2\pi\Lambda_r$	0
#12. Exit energy to extract electron from cell	W_{ex}	½ $K\Lambda_2^2$ = ½ $m_e c^2$	0
#13 Critical voltage for pair production	V_c	$1.022x10^6$ V/m	0

18. CONCLUSION

We have found a remarkable, self-consistent new space that will prove to lead to a new view of the cosmos. The bulk modulus and density yield a sonic velocity c. The reason these qualities of quantum vacuum/Espace had not been discovered earlier is that permittivity was regarded merely as an arbitrary constant in the antiquated gaussian school of electrostatics. SI itself was accepted slowly, being regarded as simply an effort to introduce practical units. To be fair, permittivity is not a factor in most physics, neither is it (nor vacuum) discussed in most texts, reflecting an ongoing antipathy to the concept of a "real" permittivity.

Our new space differs from Dirac's mathematical sea (from the minus sign in Eq. (15) whereas pair-space derives from a viable physical model. The quantum vacuum, in the guise of Zero Point Energy, has been proposed as an infinite energy bank, but in our model it is clear that there is no possibility of free energy. The establishment of this new separate space is merely the first step in ridding us of the "tyranny of the vacuum" i.e. having to rely on laws that mysteriously work in a vacuum. The reader who has come thus far will ask what more can be done with a space like this? We show in [1] that quantum vacuum acts as the feedstock of material (electrons) from which our universe was formed!

19. NOTES:

This paper is a precis of Chapters 3, 5 and 6 of Dual Space [1]. The whole of Dual Space theory encompasses new theories of creation, gravity, relativity and cosmology. The intention is to follow up with four more papers that parallel the book. The book may be obtained by inquiring at jpolasek@cfl.rr.com.

APPENDIX

20. DIRAC'S CONTRIBUTION

(While our analysis is totally independent of Dirac's, it is still interesting to note that as a preeminent physicist he had no qualms about proposing a new world.)
In 1927 Dirac introduced relativity into quantum mechanics and was able to predict the existence of a positron or equivalent particle. He deduced a whole other world of negative energy, a sea of electrons, from (we assume) just the presence of the negative sign in the relativistic total energy equation [7]:

$$W = \pm\sqrt{p^2c^2 + m^2c^4} \tag{15}$$

His sea was of electrons and holes but even after Anderson's demonstration, he was in no hurry to replace the holes with positrons or pairs for that matter.

21. DIRAC'S BLIND SPOT

Unfortunately, since the Gaussian electromagnetics of his time did not recognize permittivity, Dirac could not investigate it. This inherent deficiency in the gaussian system is seen when comparing the constitutive equations of the respective SI and gaussian systems:

$$\begin{array}{ll} \text{SI}: \ \mathrm{D} = \varepsilon_0 E + P \ \text{Coul/m}^2 & \text{gaussian}: \ \mathrm{D} = \mathrm{E} + 4\pi\mathrm{P} \quad \text{units?} \\ \dfrac{\partial D}{\partial E} = \varepsilon_0 & \dfrac{\partial D}{\partial E} = 1 \end{array} \tag{16}$$

Note that in the SI side of (16a) the units are coulombs/meter^2 but are undefined in the gaussian side which combines electric field intensity E with D and P, which are polarization charge density, therefore the equation is not homogeneous. Cause and effect are equivocated, and the sensitivity 1.00 is more than a tautology: it rejects vacuum permittivity and makes it impossible to derive the properties we have found. A hypothetical experiment that would justify the gaussian equation would be a pair of charged plates whose voltage difference would decline upon introduction of a dielectric into the gap. Such a premise is too feeble as a basis for a theory. It ignores the fact that all material whatsoever exhibits a resistance or compliance to mechanical and electrical forces as indicated in the SI equation.

20. DIRAC'S SEA.

Dirac materialized his space of negative energy as a sea of electrons with holes, and later he proposed replacing the holes with protons and finally positrons were the logical choice. He apparently did not act on this information to update his sea of electrons. His hole theory still is used in some versions of quantum physics, where positrons are sometimes viewed as electrons moving backwards in time.
In Dirac's own words [3]:

> "And then I got the idea that because the negative energy states cannot be avoided, one must accommodate them in the theory. One can do that by setting up a new picture of the vacuum. Suppose that in the vacuum all the negative energy states are filled up. The possibility of doing that arises because the exclusion principle of Pauli prevents more than one electron being in any state. We then have a sea of negative energy electrons, one electron in each of these states. It is a bottomless sea, but we do not have to worry about that. The picture of a bottomless sea is not so disturbing, really. We just have to think of the situation near the surface, and there we have some electrons living above the sea that cannot fall into it because there is no room for them." "There is, then, the possibility that holes may appear in the sea. Such holes would be places where there is an extra energy, because one would need a negative energy to make such a hole disappear. Also, such a hole would move as though it had a positive charge. It has an absence of negative charge; so in that respect. also, it appears as a positive charge. Thus the holes appear as particles with positive energy and positive charge".
>
> "When I first got this idea, it seemed to me that there ought to be symmetry between the holes and the ordinary electrons, but the only positively charged particles known at that time were the protons; so it seemed to me that these holes had to be protons. I lacked the courage to propose a new kind of particle. I should say that there were good grounds for belief at that time that there were only two particles, two basic charged particles--electrons and protons. There were just two kinds of electricity, positive and negative, and one needed one particle for each kind of electricity. In those days the climate of opinion was very much against the idea of proposing new particles. I

certainly did not dare to do it; so I published my idea as a theory of electrons and protons, and I believed that maybe the difference in mass between the electrons and protons would come about in some way from the interaction between the electrons. But I realized the difficulties were enormous because the difference in mass was so great".

"I was soon assailed by other physicists on the grounds that there could not be this difference between the mass of the new particles, the holes, and the mass of ordinary electrons. The person who most definitely came out against it was Hermann Weyl; he was essentially a mathematician and was not so much disturbed by physical realities but was very much dominated by mathematical symmetries. He said quite categorically that the new particles formed by these holes would have to have the same mass as the electrons, and I came around to that point of view. We all know the consequences of that. The new particles were given the name of anti-electrons and were afterward discovered by the experimenters. The first was Carl Anderson one of the chief physicists whom we have to thank for that. Thus this question has now been resolved"

21. PERMITTIVITY.

Permittivity's coefficient farads per meter may be clarified by the following expansion:

$1\,farad = 1 coul/volt$ Let $k = 8.8 \cdot 10^{-12}$

$$\varepsilon_0 = k \cdot farad/m = k \cdot \frac{coul/volt}{meter} = k\frac{coul/m^2}{volt/m} = \frac{chg.density}{voltage.gradient} = \frac{D}{E}$$

Author may be reached at jpolasek@cfl.rr.com with web-site http://www.dualspace.net.

REFERENCES

[1] Polasek, John C., Dual Space-the Second Half of Physics, Principia Publishing Co. 2004
[2] Misner, Thorne and Wheeler, Gravitation, Freeman Publishing, 1973
[3] M. Brown and Lillian Hoddeson, "The Birth of Particle Physics", Essay by P.A.M. Dirac entitled "Origin of Quantum Field Theory", 1988.
[4] Melissinos, A. C., "The Spontaneous Breakdown of the Vacuum", arXiv:hep-ph/9805507 v1 29 May 1998
[5] Ringwald, A., "Boiling the Vacuum with an X-ray Free Electron Laser", arXiv:hep-ph/0304139 v1 15 Apr 2003.
[6] J. Schwinger, Phys. Rev. 82, 664 (1951); 93,615 (1954).
[7]. Eisberg, Robert Martin, "Fundamentals of Modern Physics", Wiley, 1961.