A NEW THEORY OF ELECTROMAGNETISM AND GRAVITY

by

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NOTATION

$\mathbf{E}$	Electric field intensity.	(Vector)
$\mathbf{H}$	Magnetic field intensity.	(Vector)
$\mathbf{D}$	Dielectric displacement.	(Vector)
$\mathbf{B}$	Flux density.	(Vector)
$\mathbf{J}$	Conduction current density.	(Vector)
$\mathbf{J}^{*}$	Total or compound current density.	(Vector)
$\mathbf{n}$	Unit outward normal.	(Vector)
∇^2	The Laplacian.	
$\mathbf{a}$	Acceleration.	(Vector)

V	Voltage or line voltage.
I	Current or line current.
I^{*}	Total or compound current.
I_m	Moment of Inertia.
Z	Impedance or series impedance.
Z_0	Characteristic Impedance.
η	Intrinsic Impedance.
$\mathcal{Z}$	Impedivity.
R	Resistance or series resistance per unit length.
R	$= a_c/2$ = Radius of gyration.
X	Reactance or series reactance per unit length.
L	Inductance or series inductance per unit length.
l	Length or inductance per unit length.
M	Mutual inductance.
M_s	Spin magnetic moment.
M_B	Bohr Magneton($e\hbar/2m_ec$)
Y	Admittance or shunt admittance.
$\mathcal{Y}$	Admittivity.
G	Conductance or shunt conductance per unit length.
G	Gravitation constant ($6.670 \pm 0.005 \times 10^{-8}$ dyne cm^2 grm^{-2})
C	Capacitance or shunt capacitance per unit length.
c	Velocity of "light" in vacuo.
σ	Conductivity.
ρ	Resistivity.
s	$= a+ib$ = exponent of excitation function Ae^{st}

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ϵ	Permittivity.
ϵ	Eccentricity of an ellipse.
μ	Permeability.
ω	Angular velocity or frequency ($2\pi f$).
γ	Propagation function (exponent) $= \alpha + i\beta$ per unit length.
γ_e	Magneto - gyric (or gyro-magnetic) ratio - electron.
α	Attenuation function of γ
α	Sommerfeld Fine Structure Constant ($e^2/\hbar c$)
β	Phase function of γ
ϕ	Flux
$\emptyset$	Velocity ratio (v/c)
Ω	Relativistic transformation function $\sqrt{1-\emptyset^2}$
Θ	γz Propagation function (exponent)
x,y,z	Rectangular co-ordinate axes.
t	Time or period.
τ	Reciprocal Hubble's Constant (H^{-1})
A	Area.
B	$= G(m_e/e)^2$ is the ratio of gravitational to electric force (electron)
A	Used for various functions and constants
B	defined at the appropriate place in the text.
C	"
D	"
F	Magnetomotove force or force generally.
P	$= (\omega\Delta/c)^2$ Mass or velocity transformation ratio.
Δ	Abbreviation of Δz, an infinitesimal length along z axis.
δ	Velocity difference.
P_0	Permeance.
R_0	Reluctance.
N	A general number or mass ratio.
n	Scalar integer.
U,K,V,E	Energies.
V	Volume.
u,v,w	Velocities (scalar)
V_s	Separation or recession velocity.
$V_{s(v)}$	Apparent separation velocity ($v - c$).
r	Radius (variable)
a	A particular value of r, or semi-major axis.
a_c	Compton radius $\hbar/m_e c$
a_{ce}	Compton radius of electron.

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b	Semi-minor axis of ellipse.
f	Frequency (replaces ν in particle physics)
λ	Wavelength.
λ_c	Compton wavelength
Λ	(Capital Lambda) Anomalous dispersion factor.
h	Planck's constant.
$\hbar$	$= h/2\pi$
m	Mass
e	Charge of the electron (e.s.u.)
e'	Charge of the electron (e.m.u.) $= e/c$
p	Momentum, either linear or angular.
Q	Area constant ($k\hbar/m_e$)
ν_e	Electron neutrino.
ν_μ	Muon neutrino
e.v.	Electron volt.
M.e.v.	Million electron volts.
B.e.v..	Billion electron volts.
k	Coefficient of coupling or transformer coupling factor.
k_1	(M_s/M_B) Anomalous magnetic moment of the electron.
k_2	(r_0/a) A ratio of radii.
k_3	($\frac{3\Lambda - 2}{3\Lambda^2 - 2}$) A fine structure constant.
k_4	$\sqrt{b/a}$ where b, a, are semi-minor and major axes of ellipse.
k_5	(v/c)^2 a velocity ratio (squared) where $v < c$

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APPENDICES

A   Transmission Line Form of Maxwell's Equations.

B   Approximate Macroscopic Solutions.

C   Electron/positron Equations.

D   Spherical Waves.

E   Lorentz Transformation and the Transmission Line Equations.

F   Extra-galactic Red Shift.

G   Electron/Muon and Electron/Muon Neutrinos Relationships.

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Summary.

1. For over 300 years the conflict between electromagnetic wave and particle theories has engaged the minds of physicists and mathematicians, the cleavage being accentuated rather than reduced by the advent of wave mechanics. The classical electromagnetic theory of Maxwell, which has never claimed to be other than a linear, macroscopic theory, fails to explain the known, quantized, particle structure of the Universe and yet it provides an excellent fit to the experimental data at lower frequencies.

2. The linear electromagnetic equations, which ignore all higher order terms are, like the equation of S.H.M. applicable to the spring-supported mass and the pendulum, only true as the displacement tends to zero. By means of lasers it has recently been proved that optical media are amplitude non-linear. Nor is the vacuum an exception to this rule. The fact of Dirac's vacuum state is amply supported by experimental evidence of electron-positron pair production and annihilation (Ref. 10, pp. 214 to 219). The vacuum can be ionized, to yield a pair, with a potential energy of $2m_e c^2 \simeq 1{\cdot}02$ Mev. and this corresponds to the resonant peak of the dispersion characteristic. Optical photons with energies of only one to three ev. can produce virtual pairs in the phenomenon of light scattering by light, demonstration of which, in vacuo, awaits the inevitable development of more powerful lasers and x-ray-asers.

3. Perhaps least well known of all the anomalies are the contradications within the classical theory itself. These are discussed at some length in this paper.

4. All these anomalies spring from the same root cause and in order to eliminate them a new unified theory of electromagnetism and gravity has been developed by the Author over the last 10 years. This theory, which quantizes naturally and necessarily, removes all the known anomalies and yields Maxwell's equations as a very good approximation when the signal frequency is so low compared with the "Zitterbewegung" frequency of the electron that the use of differential wave equations introduces negligible error. This paper is a synopsis of a book which is soon to be published.

Microscopic Domain.

5. The historic conflict between wave and particle theories is well covered in the literature (e.g. Refs. 1 and 2). Electromagnetic theory evolved from the optical studies of Descartes, Snell, Fermat, Hooke, Grimaldi, Newton, Roemer, Bartholin, Huygens, Fresnel and others.

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Isaac Newton (1642 - 1727) attempted unsuccessfully to establish an association between waves and corpuscles with his theory of "fits of easy reflection and easy transmission". Christiaan Huygens (1629 - 1695) successfully explained refraction and reflection by his principle that each surface element of a wave-front comprises a secondary point source. Augustin Fresnel (1788 - 1827) attempted to extend the wave theory of Huygens to an elastic aether capable of only transverse vibrations. The concentrated efforts of many able scientists and mathematicians, such as Poisson, Green, MacCullagh, F. Neuman, Carl Neumann, Lord Rayleigh, Kirchhoff and Lord Kelvin failed to establish a definite coherent theory of aether vibrations. Perhaps the most successful model was the vortex-sponge. About 1873, James Clerk Maxwell created his famous theory of electromagnetism (Ref. 3), which involved a "luminiferous aether" as a transmission system to convey and temporarily to store electromagnetic energy.

6. The electron theory of H. A. Lorentz created new conflicts. Firstly, Maxwell's electrodynamics demanded that the orbital electrons in atoms, because of their inward radial acceleration, should continuously radiate energy and fall into the nucleus. Secondly, statistical thermodynamics gave incorrect results for specific heats at low temperatures, leading to the unacceptable requirement for infinite total energy density. The latter problem was overcome in 1900 by Max Planck's quantum theory, which Debye applied to specific heats with great success. This, together with Einstein's explanation of the photo-electric effect in 1905, proved beyond doubt that radiation and absorption of electromagnetic energy occur in quanta or photons. Planck was greatly concerned by the implication of his own theory, that radiation itself would, therefore, need to be discontinuous or quantized. He tried hard to evolve a less radical theory, which would permit continuous transmission and absorption, but he was unsuccessful.

7. Maxwell failed to explain the physical meaning of displacement current in vacuo. He summarized the subject of the aether as follows:- "But in all theories the question naturally occurs - if something is transmitted from one particle to another at a distance, what is its condition after it has left the one particle and before it has reached the other? ... hence all these theories lead to the conception of a medium in which the propagation takes place ... and we ought to endeavour to construct a mental representation of all the detail of its actions and this has been my constant aim in this treatise". Sir Isaac Newton also rejected the idea of force at a distance in a vacuum. Although Einstein concluded from his Special Relativity Theory that the existence of a Maxwellian aether was superfluous, because an absolutely stationary space was unnecessary, it is generally considered that this does not constitute proof of its non-existence. The identification of Dirac's vacuum state with the Maxwellian aether was a natural step. Displacement current in vacuo must involve charge or virtual charge. All charge is quantized. If Maxwell's theory provides an exact description of the physics of the vacuum should it not also yield, unaided, Planck's theory, Bohr's frequency/energy relationship for atomic states, and Schrödinger's quantized wave equation?

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8. At one period the vacuum was considered to be the quintessence of "nothingness" but now it appears that the vacuum is a plenum - the quintessence of abundance. In Dirac's vacuum all negative energy states are occupied by negative energy, negative mass electrons, whereas all the positive energy states are unoccupied. When a negative energy electron is given a quantum of $2m_e c^2$ it is raised to a positive energy state and it leaves a "hole" which has the effect of a particle with positive energy $m_e c^2$ and positive rest mass , but with positive charge (a positron). (Ref. 10, pp. 214 to 219). Therefore, the vacuum can be ionized by a potential (energy) of

$$U = E.e.a_c = 2 m_e c^2 \simeq 1 \cdot 022 \text{ Mev.}$$

$$\simeq 1 \cdot 6 \times 10^{-6} \text{ ergs.} \quad \ldots(1)$$

with an associated critical field of

$$E_{crit.} = \frac{2 m_e^2 c^3}{e \hbar} \simeq 8 \cdot 8276 \times 10^{13} \text{ gauss, or e.s.u. volt/cm}$$

$$\simeq 2 \cdot 6464 \times 10^{18} \text{ volts/metre} \quad \ldots(2)$$

where $2\pi a_c = \lambda_c = \dfrac{h}{m_e c}$ is the Compton wavelength of the electron/positron.

Compare this with the ionization potential of hydrogen.

$$U_o = \frac{m_e e^4}{2 \hbar^2} = \frac{e^2}{2 a_o} \simeq 13 \cdot 5 \text{ ev.} \quad \ldots(3)$$

where $a_o = \dfrac{\hbar^2}{m_e e^2} = \dfrac{r_o}{\alpha^2}$ is the First Bohr Radius.

9. At energy levels lower than the vacuum ionization potential, two opposed photons can produce a virtual pair. With the annihilation of this virtual pair the photons go off in altered directions, displaying the effect of the scattering of light by light - non-linear optics compared with Maxwell's linear optics. This inherent non-linearity of material media has now been demonstrated by means of lasers (e.g. Ref. 4, page 140, Refs. 5 and 6). Demonstration that the vacuum is not an exception to the non-linear rule awaits the development of higher-powered lasers, possibly "x-ray-asers". The strongest magnetic fields that can now be produced by means of super-conducting coils are in the order of 100,000 to 300,000 gauss (see equation 2). It is not possible to demonstrate the vacuum ionization potential by applying an electrostatic field because of the low work function of metals even when cold, yielding cold emission from the electrodes.

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10. The problem of gravity is well summarized by George Gamow (Ref. 7). He points out that Michael Faraday remained convinced that there must be some relation between gravity, electricity and magnetism, notwithstanding his repeated failure to find it. He stressed that the theory of gravity stands in majestic isolation. In spite of many attempts, Einstein and those who have followed him have failed to establish any contact between gravity and Maxwell's electrodynamics. In 1933 Neils Bohr raised the interesting question of the possible relation between neutrinos and gravitational waves. A few years ago Dirac succeeded in quantizing the gravitational field equations and gave us the graviton with spin 2.

Macroscopic Domain.

11. Classical electromagnetic theory based on Maxwell's equations is a macroscopic theory (Ref. 8, Page 2). In the light of recent experiments in non-linear optics, it is clear that it is also a small signal theory, strictly only true for infinitesimal displacements. However, with these two provisos, it is true that no experimental evidence in the optical and radio-frequency spectra has proved Maxwell's equations to be sensibly in error. This is hardly surprising. For frequencies appreciably less than the electron "Zitterbewegung" frequency:-

$$f_z = \frac{2 m_e c^2}{h} \simeq 2 \cdot 471,256,38 \times 10^{20} \text{ cps.} \quad \ldots(4)$$

the correction factor to the phase function (for example) as yielded by the new theory is a pure number Λ only very slightly less than unity:-

$$\Lambda \simeq 1 - 10^{-38} \quad \ldots(5)$$

Because all experimental data is statistical and prone to error, consistency with such data is a necessary but insufficient criterion for testing the accuracy of a theory. In the present case the experimental errors are many orders greater than the theoretical errors.

12. Setting aside the numerical error, dissatisfaction is principally confined to our inability, satisfactorily to represent Maxwell's equations in the form of an equivalent transmission network. Quite often, in the literature, attempts have been made to represent Maxwell's equations for plane wave propagation in the form of an equivalent transmission line, but with strange and bewildering results. To those who might object to the use of transmission line concepts in a field theory-cum-particle analysis, attention is drawn to a most significant correlation between the transmission line equations and the Lorentz Transformations (Appendix "E"). It is also of significance that the anomalies inherent in the classical field theory are also disclosed in a rigorous analysis of the transmission line compared with Kelvin's "Telegraphers Equations". In addition, the interpretation of the point function forms leads to anomalies.

13. Maxwell's equations for an infinite, homogeneous, isotropic medium with zero free charge are:-

$$\nabla \times \mathbf{E} = -\mu \frac{\partial \mathbf{H}}{\partial t} \qquad \ldots(6)$$

$$\nabla \times \mathbf{H} = \left(\sigma + \epsilon \frac{\partial}{\partial t}\right)\mathbf{E} \qquad \ldots(7)$$

$$\nabla \cdot \mathbf{E} = 0 \qquad \ldots(8)$$

$$\nabla \cdot \mathbf{H} = 0 \qquad \ldots(9)$$

and taking the special case of a plane wave with the direction of propagation coincident with the z axis of rectangular co-ordinates, defined by unit outward normal vector $\mathbf{n}$, the vector algebra manipulation as shown in Appendix "A", yields the equations for harmonic excitation:-

$$\frac{\partial \mathbf{E}}{\partial z} = -i\omega\mu\,(\mathbf{H} \times \mathbf{n}) \qquad \ldots(10)$$

$$\frac{\partial}{\partial z}(\mathbf{H} \times \mathbf{n}) = -(\sigma + i\omega\epsilon)\mathbf{E} \qquad \ldots(11)$$

which are usually then compared with the transmission line scalar equations.

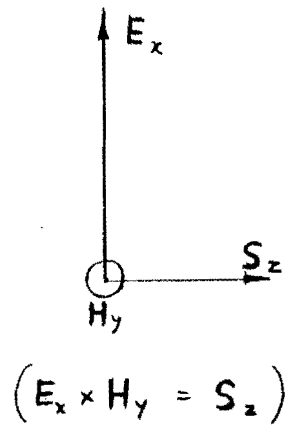
$$\frac{\partial V}{\partial z} = -Z I \qquad \ldots(12)$$

$$\frac{\partial I}{\partial z} = -Y V \qquad \ldots(13)$$

to yield the following dubious equivalents.

Transmission Line		Field Equations	
Function	Direction	Function	Direction
Line current I	$\pm$ z	$\mathbf{H} \times \mathbf{n}$	$\pm$ x
Shunt current YV	$\pm$ x	$(\sigma + i\omega\epsilon)\mathbf{E}$	$\pm$ x
Series impedance $R + i\omega L$	$\pm$ z	"Impedivity" $0 + i\omega\mu$	$\pm$ x
Shunt admittance $G + i\omega C$	$\pm$ x	"Admittivity" $\sigma + i\omega\epsilon$	$\pm$ x

with an associated prototype half-circuit diagram:-



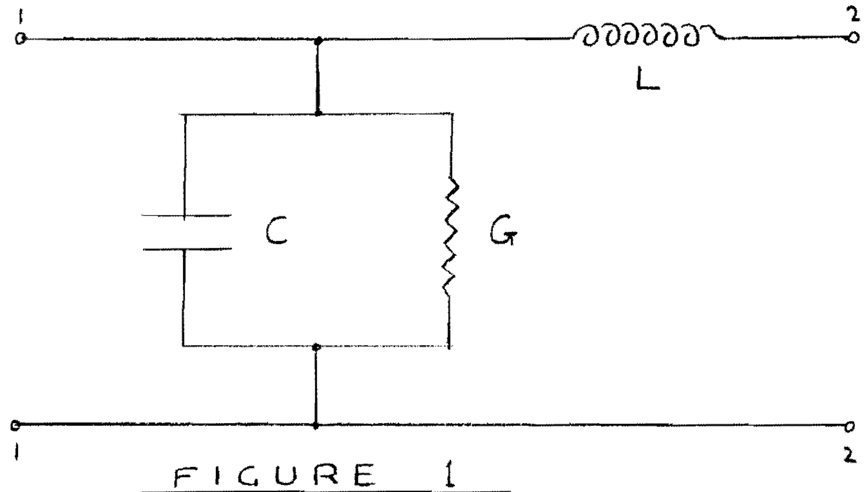


FIGURE 1

14. It should be emphasized that the use of a plane wave analysis is in no way restrictive, because any field configuration can be produced by the super-position of the requisite number of plane waves having suitable amplitudes, phase and polarization to suit the boundary conditions.

15. The following questions spring to mind:-

a) Why is it that the line current equivalent $(\mathbf{H} \times \mathbf{n})$ flows across the wavefront in the same direction as, and superimposed upon the shunt current of density $(\sigma + i\omega\epsilon)\mathbf{E}$. Should not Maxwell's equations yield the complex resultant of these currents? In the transmission line they are at right angles.

b) Why is it that in an isotropic, homogeneous linear medium which, by definition, is described by three constants σ, ϵ, and μ, there is finite conductivity in the $\pm$x direction as shown by the shunt current "admittivity" $\sigma + i\omega\epsilon$ (for a general medium having conductivity), but that the series "impedivity" $i\omega\mu$, which is measured in the same direction $\pm$x, exhibits zero resistivity instead of $\rho = 1/\sigma$?

c) Why does the shunt "admittivity" not include a reciprocal inductive term and why does the series " impedivity" not include reciprocal conductivity and permittivity terms?

The Impedance/Admittance of the Medium.

16. The basic problem is that of correctly defining the impedance ("impedivity") or admittance ("admittivity") of the medium. Maxwell stated that the medium is, in general, homogeneous, isotropic, linear and is described by three electromagnetic constants σ, ϵ, μ . He produced two equations, the first (eqn. 6) was Faraday's law of electromagnetic induction and the second (eqn. 7) was a form of Ampere's Law. These he derived from the time variation of the electrostatic, magnetostatic and D.C. Ohm's Law equations (Ref. 3, Articles 608, 609, 614):-

$$\mathbf{D} = \epsilon \mathbf{E} \quad \ldots(14)$$

$$\mathbf{B} = \mu \mathbf{H} \quad \ldots(15)$$

$$\mathbf{J} = \sigma \mathbf{E} \quad \ldots(16)$$

/7...

16. Continued...

He carried over these steady-state equations into the time-varying domain without modification (e.g. a wire exhibits a pure resistance to steady-state D.C. but a complex impedance to A.C.)

17. In order simultaneously to solve his two equations ((6) and (7)) in three unknowns $\mathbf{E}$, $\mathbf{H}$ and $\mathbf{J}^{x}$ (the "true" or total current density) he required a third equation relating $\mathbf{E}$ and $\mathbf{J}^{x}$. Clearly, the required equation is a generalized form of Ohm s Law for time-varying fields.

$$\mathbf{J}^{x} = \gamma \mathbf{E} \qquad \ldots(17)$$

where γ = admittivity (analogous to conductivity, permittivity and permeability)

Is there any way of obtaining the correct expression for the admittivity of the medium except by some form of network theory? Is it driving point, transfer or characteristic admittivity? In 1873, Maxwell did not possess the relatively modern and powerful tool called Network Analysis/Synthesis and it appears that he chose the incorrect solution. Using modern notation but otherwise quoting verbatim from Ref. 3, Article 611 ... "since both $\mathbf{J}$ and $\mathbf{D}$ depend on the electromotive intensity $\mathbf{E}$, we may express the true current $\mathbf{J}^{x}$ in terms of the electromotive intensity, thus ...."

$$\mathbf{J}^{x} = \mathbf{J} + \frac{\partial \mathbf{D}}{\partial t} = \left(\sigma + \partial/\partial t\right)\mathbf{E} \qquad \ldots(18)$$

In how many ways may one variable depend on another?

18. To those who may wish to deny that equivalent network theory has a legitimate place in wave/particle theory, it is suggested that, even if Maxwell was unaware of the need for a 4-terminal prototype network, he must have seen in his mind's eye a parallel circuit, like Figure 2, in order to justify his decision to add the current densities.

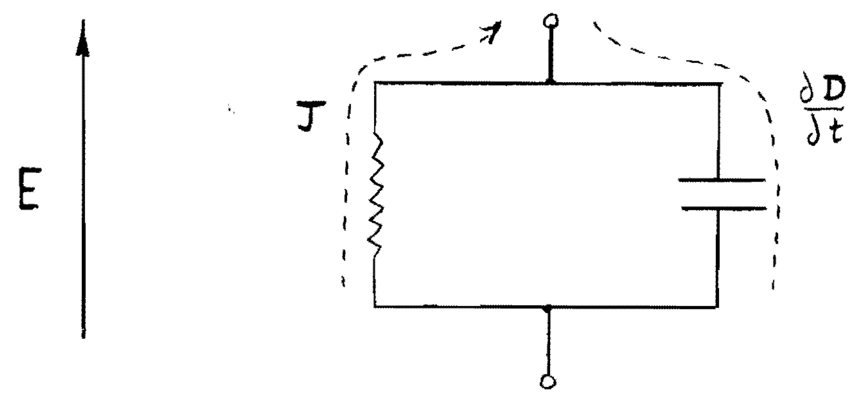


FIGURE 2

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18. Continued...

But where is the inductive term? He was well aware that the time-varying magnetic field produced by his "true" current represented a time-dependent storage of energy, imparting to the phenomenon the inductive effect correctly specified by his first equation (eqn. 6). What, apparently, he failed to appreciate was that a back-e.mf. of self-induction must also be taken into account in determining the relation between the "true" current density $\mathbf{J}^x$ and the driving-point field intensity $\mathbf{E}$, so that all three constants σ, ϵ and μ, appear in the expression for $\mathcal{Y}$.

19. The argument has been suggested to the Author that the reason why the inductive term is missing is that the circular lines of magnetic flux arising from each current filament exactly cancel out their neighbours. Clearly this is not a valid argument for two reasons:-

a) It is impossible to achieve in-phase, equal amplitude excitation throughout infinite space.

b) Even if such excitation were possible the situation does not describe a wave phenomenon.

20. However, it is not necessary to introduce new arguments to prove that there is an inductive term missing from the current equation. Maxwell's equations themselves can be used to prove this point and, therefore, to prove that they are mutually incompatible. The problem of solving the admittivity term $\mathcal{Y}$ can be avoided by leaving Maxwell's equations in the following form, which for small signals in the macroscopic domain are sensibly correct (see eqns. 6, 7, 8 and 9).

$$\nabla \times \mathbf{E} = -\mu \frac{\partial \mathbf{H}}{\partial t} \qquad ...(19)$$

$$\nabla \times \mathbf{H} = \mathbf{J}^x \qquad ...(20)$$

$$\nabla \cdot \mathbf{E} = 0 \qquad ...(21)$$

$$\nabla \cdot \mathbf{H} = 0 \qquad ...(22)$$

where $\mathbf{J}^x$ is the "true" or total current density which, for harmonic excitation is complex, in general. Multiplying (20) by the scalar constant μ, taking the curl of (19) and eliminating $\nabla \times \mathbf{B}$ by means of (20) we get:-

$$\nabla \times (\nabla \times \mathbf{E}) = -\mu \frac{\partial \mathbf{J}^x}{\partial t} \qquad ...(23)$$

but

$$\nabla \times (\nabla \times \mathbf{E}) = (\nabla \cdot \mathbf{E}) \nabla - \nabla^2 \mathbf{E} \quad \text{identically,}$$

and the first term of the right-hand side vanishes in virtue of (21), hence, equation (23) becomes:-

$$\nabla^2 \mathbf{E} = \mu \frac{\partial \mathbf{J}^x}{\partial t} \qquad ...(24)$$

/9...

20. Continued...

where $\nabla^2 = \partial^2/\partial x^2 + \partial^2/\partial y^2 + \partial^2/\partial z^2$ is the Laplacian

21. Now, for plane wave propagation in the direction of the z axis the vectors **E** and **H** are constant in direction and magnitude over the x, y plane (the validity of a plane wave analysis has already been discussed). Hence, equation (24) becomes:-

$$\frac{\partial^2 E}{\partial z^2} = \mu \frac{\partial J^x}{\partial t} \qquad ...(25)$$

Integrating (25) with respect to z, bearing in mind that these are partial derivatives and that J is a function of both **E** and t,

$$\frac{\partial E}{\partial z} = \mu \frac{\partial}{\partial t}\int J^x\, dz + (\text{function of } t) \qquad ...(26)$$

Now (26) must be true for all values of E including zero, therefore, when $E = 0$, $J = 0$ and its integral is constant. The function of t must, therefore, be zero (constant). Clearly

$$\int J^x\, dz = I^x \qquad ...(27)$$

is the aggregate compound current sheet contained within the differential interval dz, therefore, finally,

$$\frac{\partial E}{\partial z} = \mu \frac{\partial I^x}{\partial t} \qquad ...(28)$$

which should be compared with the expression derived for a distributed circuit inductance (e.g. Ref. 9, page 17).

$$\frac{\partial e}{\partial z} = \ell \frac{\partial i}{\partial t} \qquad ...(29)$$

This proves that the medium is inductive.

22. The final anomally to merit consideration is that of the point function forms of Maxwell's equations. As that eminent authority J. A. Stratton points out (Ref. 8, pp. 2, 3) classical electromagnetic theory is essentially a macroscopic theory because there is a quantized particle structure associated with electricity and magnetism, to the

22. Continued...

dimensions of which it is impossible to proceed without failure of the theory. Stratton suggests that the macroscopic element of volume must contain an enormous number of atoms and he proposes a limit of one-tenth of a millimetre as the smallest admissible element of length. For example, charge density is defined as the average charge per unit volume in the neighbourhood of a point. In a strict sense this cannot be defined as a continuous, analytic function of position because the volume element, Δv cannot approach zero without limit. Electrons are finite and quantized. On the other hand the functions divergence and curl are pure mathematical limits to which the integrals per unit volume and area, respectively, tend as the volume and area tend to zero. Clearly, an approximation is involved in these forms (eqns. 6, 7, 8 and 9) and the new theory defines it.

The New Theory.

23. The basic problem has been shown to be the determination of the relationship between E and J^x in a representative volumetric model. The new theory obtains an equivalent 4-terminal network by means of the well-established Field Cell Theory (e.g. Ref.11). Because the equivalent "lumped circuit" elements have no real "terminals" it is necessary to impose a discipline on the form of excitation, and this, traditionally, is a plane wave (paragraph 14). The excitation function will be taken as the general exponential function (Ref. 9, page 28).

$$A e^{st}$$

24. Consider a rectangular volume within a plane wave, orientated along the co-ordinate axes, as in Figure 3.

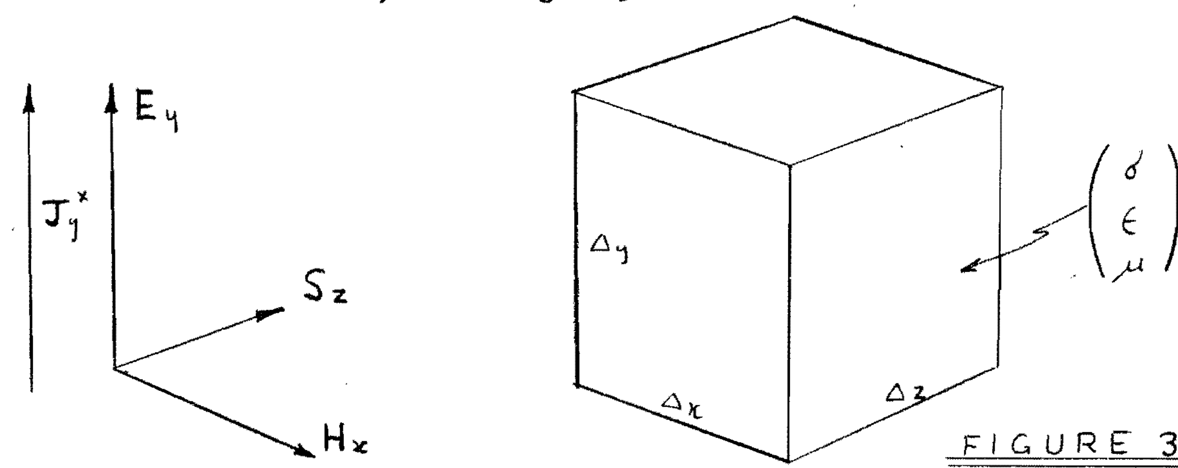


FIGURE 3

By the methods described in the literature, the following relationships may be written down:-

Conductance.

$$G = \sigma \frac{\Delta x \Delta z}{\Delta y} = \sigma \Delta z \quad (\text{for } \Delta x = \Delta y) \qquad \ldots(30)$$

24. Continued...

Capacitance.

$$C = \epsilon \frac{\Delta x \, \Delta z}{\Delta y} = \epsilon \, \Delta z \; (\text{for } \Delta x = \Delta y) \qquad \ldots(31)$$

Inductance.

$$L = \mu \frac{\Delta y \, \Delta z}{\Delta x} = \mu \, \Delta z \; (\text{for } \Delta x = \Delta y) \qquad \ldots(32)$$

The least obvious of these relationships (eqn. 32) may also be obtained by two quite different methods described in the literature. Firstly, by the concept of metal sheet transmission lines (Ref. 11, page 177) and secondly, by the definition of reluctance and permeance which is equally applicable to non-ferromagnetic media (Ref. 11, pages 251 etc.)

25. It will be noted that, although G, C and L are all of the same form, per-unit square ($\Delta x = \Delta y$), G and s C are admittances but s L is an impedance. They will, therefore, appear in combination, typically, as follows:-

$$Z = \frac{1}{(\delta + s\epsilon)\Delta z} + s\mu\,\Delta z \qquad \ldots(33)$$

and the resultant impedance of the cell changes qualitatively as well as quantitatively as Δz is changed. Therefore, even when the medium is intrinsically isotropic and homogeneous it possessed volumetric inhomogeneity in terms of cell impedance. For this reason, the choice of Δz is far from arbitrary. The quantized, particle nature of the Universe demands that Δz may not be allowed to go to zero without encountering some cut-off criterion. Significantly, G, C and L vanish simultaneously in the limit, $\Delta z = 0$. No electromagnetic process can occur at a mathematical point, which has position but no magnitude. A 4-terminal network must have finite dimensions.

26. With no component of **E** in the direction of propagation z and with all the current flowing in the plane of the wave-front, it is reasonable to assume that elementary current sheets are magnetically coupled. The simplest concept is, therefore, two adjacent cells which are magnetically coupled, as in Figure 4.

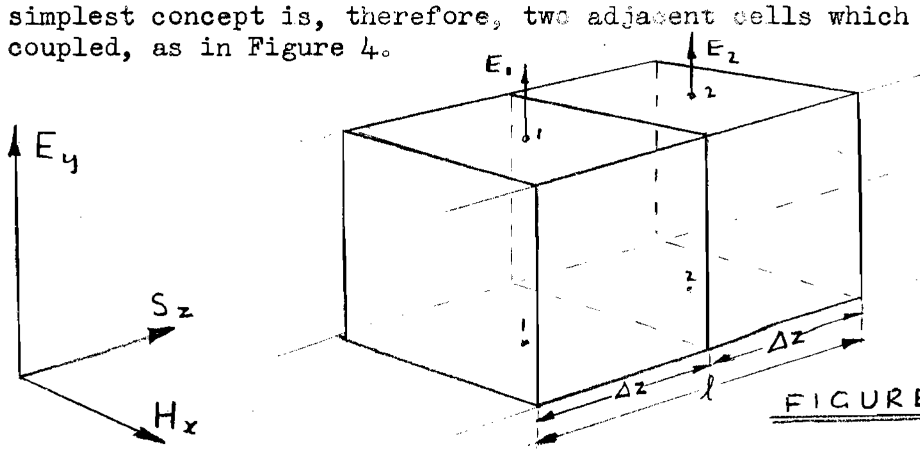


FIGURE 4

/12...

26. **Continued...**

[N.B. For simplicity of notation Δz will be written as Δ in the following analysis.]

The terminals of the equivalent network represent the electromagnetic centroids of the cells and the overall length l is exactly twice the electrical length Δ. The associated 4-terminal, transformer-coupled network is shown in Figure 5.

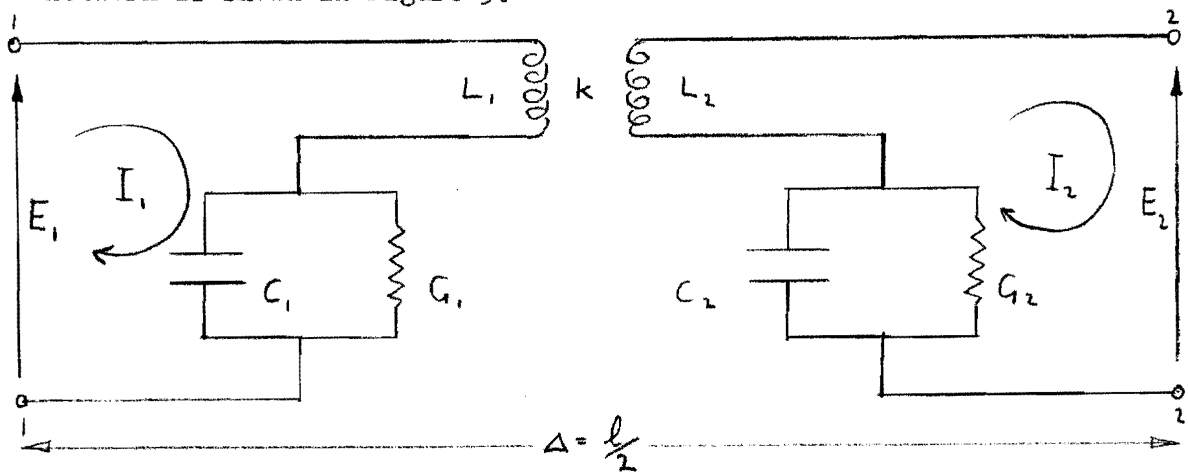


FIGURE 5

27. However, a transformer is essentially a high-pass or band-pass device and experimental evidence indicates that a low-pss response is required. There is, at present, no evidence of a low-frequency cut-off. (e.g. gravitational waves of period $\tau = 4.133 \times 10^{17}$ seconds - the reciprocal Hubble's Constant - are propagated). It, therefore, follows that both magnetic and electric couplings are required. A transformer may be represented in the form of a "T" section equivalent for the purpose of circuit analysis and the two forms of coupling can be combined in the equivalent arrangement given in Figure 6.

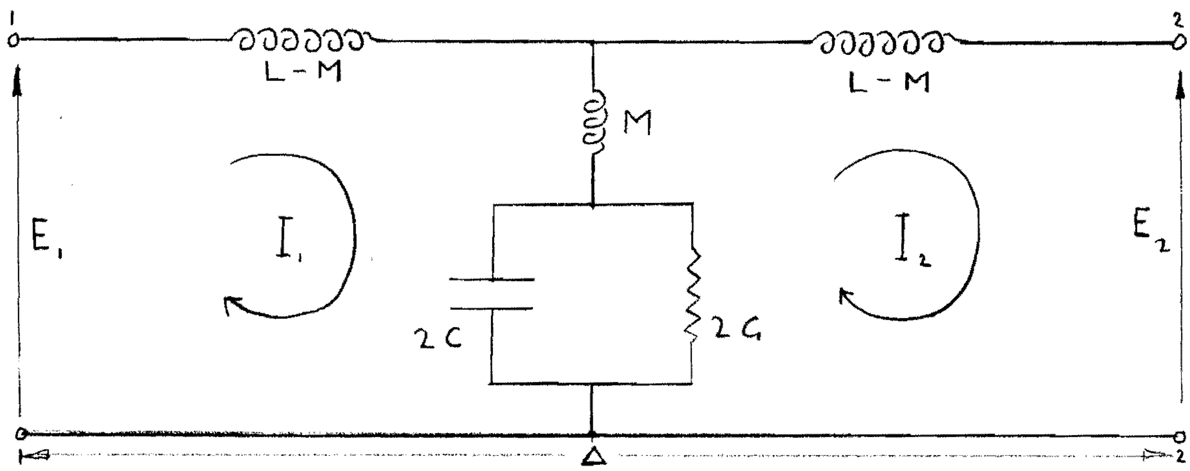


FIGURE 6

where:

M = Mutual inductance = $k\mu\Delta$

L-M = Leakage inductance = $\mu\Delta$

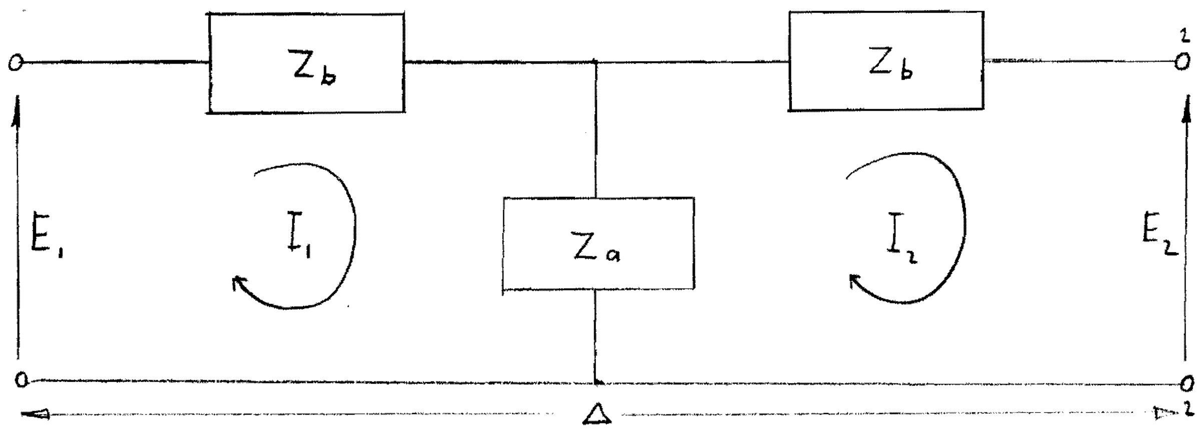
K = $\left|\frac{M}{L}\right|$ = Coefficient of coupling or coupling factor with value $0 < k < 1$

/13...

27. Continued...

Clearly a coupling factor k less than unity is necessary because the two cells cannot be coincident in space. The leakage inductance accounts for coupling to adjacent cells (particles) and hence is associated with propagation, whereas, the mutual inductance accounts for internal magnetic coupling within the cell (particle) necessary for the maintenance of oscillations. The choice of notation ($L - M = \mu\Delta$) has been made so that a direct transition to Maxwell's equations is possible at a later stage.

28. The final equivalent "T" section network can now be given:- (Figure 7).



where:

FIGURE 7

$$Z_a = kX\Delta + \frac{1}{2Y\Delta} \qquad ...(34)$$

$$Z_b = X\Delta \qquad ...(35)$$

$$X = s\mu \qquad ...(36)$$

$$Y = \sigma + s\epsilon \qquad ...(37)$$

$s = a + ib$ and for harmonic, real frequency excitation (Ref. 9). $s = i\omega$

29. The analysis of this circuit now conforms to the standard method, involving circuit parameters A, B, C, D, where in this case:-

$$AD - BC = 1 \qquad \text{(passivity)} \qquad ...(38)$$

$$A = D \qquad \text{(symmetry)} \qquad ...(39)$$

In the interest of brevity the detailed working will be omitted. (For an excellent treatment of the theory and method see Ref. 9). The results may be summarized:-

$$A = D = \frac{Z_b}{Z_a} + 1 \qquad ...(40)$$

/14...

29. Continued...

$$B = \frac{(Z_b)^2}{Z_a} + 2Z_b \quad \ldots(41)$$

$$C = \frac{1}{Z_a} \quad \ldots(42)$$

$$\cosh\theta = A = D \quad \ldots(43)$$

$$\sinh\theta = \frac{B}{\eta} = \eta C = \sqrt{BC} = \frac{Z_b}{Z_a}\sqrt{1 + 2\frac{Z_a}{Z_b}} \quad \ldots(44)$$

where $\theta = \gamma\ell$

and ℓ = propagation path length.

$$\eta = \sqrt{\frac{B}{C}} = Z_b\sqrt{1 + 2\frac{Z_a}{Z_b}} \quad \ldots(45)$$

(N.B. The intrinsic impedance η is used in preference to the characteristic impedance Z_o).

The propagation function and intrinsic impedance may be expanded for clarity:-

$$\sinh\gamma\ell = \sqrt{BC} = \frac{1}{k + \frac{1}{2XY\Delta^2}}\sqrt{(1+2k) + \frac{1}{XY\Delta^2}}$$

$$\ldots(46)$$

$$\eta = \sqrt{\frac{B}{C}} = \sqrt{(1+2k)(X\Delta)^2 + \frac{X}{Y}} \quad \ldots(47)$$

30. The network is a low-pass filter whose cut-off criteria may be determined for a lossless medium ($\delta = 0$) as shown in Ref. 9, p. 208).

$$\left(\frac{Z_{sc}}{Z_{oc}}\right)^2 = \tanh^2\theta = \frac{BC}{A^2} = 1 - \frac{1}{A^2} = 0 \quad \ldots(48)$$

with solution $A = \pm 1$

whence, from (40)

$$\frac{Z_b}{Z_a} = 0 \quad \text{or} \quad -2 \quad \ldots(49)$$

/15...

30. **Continued...**

leading to $$X Y \Delta^2 = 0$$ ...(50)

and $$X Y \Delta^2 = -\frac{1}{(1+2k)}$$ ...(51)

where , for harmonic excitation $X Y \Delta^2 = -\omega^2 \mu \epsilon \Delta^2$

and defining

$$v^2 = \frac{1}{\mu \epsilon}$$ (general medium) ...(52)

$$c^2 = \frac{1}{\mu_o \epsilon_o}$$ (vacuum) ...(53)

the cut-off criteria for the vacuum are:

1. $$\frac{2\pi\Delta}{\lambda} = \frac{\omega\Delta}{c} = i\,0$$ ...(54)

2. $$\frac{2\pi\Delta}{\lambda} = \frac{\omega\Delta}{c} = \frac{1}{\sqrt{1+2k}}$$ ...(55)

31. The first criterion shows that, at all finite frequencies greater than zero (D.C.), cut-off occurs when $\Delta = 0$. Alternatively, if Δ is non-zero, then the solution yields $\omega = 0$. This result is of great importance in that it emphasizes the fundamental fact concerning the minimum dimension of the cell. If, because of the convenience inherent in the use of differential equations, the dimension Δ (i.e. Δz) is made to proceed to the mathematical limit zero, then, for any frequency, the network cuts-off and no propagation can occur. A 4-terminal network cannot exist at a mathematical point: there must be space enough for separate input and output functions. The microscopic process depends on particles which are finite and quantized. Differential equation solutions must, therefore, be considered as approximations, valid only at wavelengths appreciably greater than the minimum value of Δ , yet to be determined. Equation 54 discloses another significant fact. As the limit is approached, there are two waves: the radiated wave, which is radial (wavelength λ) and a circumferential or spin wave (wavelength $2\pi\Delta$) which is everywhere normal to the radius Δ. Therefore, ω may be looked upon not only as a circular frequency but also an an angular velocity such that the velocity $\omega\Delta$ is at right angles to the radial dimension. Evaluation of the second cut-off criterion requires the determination of the coupling factor k, which will soon be undertaken.

32. Equations 46 and 47 may be re-arranged as follows:-

$$\sinh \gamma \ell = \sqrt{BC} = 2\Delta\sqrt{XY}\sqrt{\frac{1 + (1+2k)(XY\Delta^2)}{1 + 2k\,XY\Delta^2}}$$ ...(56)

/16...

32. Continued...

$$\eta = \sqrt{\frac{B}{C}} = \sqrt{\frac{X}{Y}} \cdot \sqrt{1 + (1+2k)(XY\Delta^2)} \qquad \ldots(57)$$

where
$$\Lambda = \sqrt{\frac{1 + (1+2k)(XY\Delta^2)}{1 + 2kXY\Delta^2}}$$

is the correction factor for the propagation function (a pure number) and the impedance correction factor is the numerator of Λ.

Now, from Figure 4, $\ell = 2\Delta$, so that equation 56 may be divided through by ℓ to yield a left-hand side.

$$\frac{\sinh \gamma\ell}{\ell} \qquad \ldots(58)$$

and $\lim_{\gamma\ell \to 0} \sinh \gamma\ell = \gamma\ell$ (which will later be seen to be approximately valid. Note that there is no problem of "terminal" interconnection at spacing Δ)

therefore, the limiting value of 56 is

$$\gamma = \sqrt{XY}\left[\lim_{\Delta \to 0} \Lambda\right] \quad (\Delta \neq 0) \qquad \ldots(59)$$

and the limiting value of 57 is

$$\eta = \sqrt{\frac{X}{Y}}\left[\lim_{\Delta \to 0} (\text{numerator of } \Lambda)\right] \quad (\Delta \neq 0) \qquad \ldots(60)$$

33. Now if we temporarily ignore the particle structure of the vacuum and, as an approximation, allow Δ to become exactly zero, equations 59 and 60 degrade to the Maxwellian solutions:-

$$\gamma = \sqrt{XY} \qquad \ldots(61)$$

$$\eta = \sqrt{\frac{X}{Y}} \qquad \ldots(62)$$

which may be expanded, for harmonic excitation, into the familiar forms:-

33. Continued...

$$\gamma = \alpha + i\beta = \sqrt{i\omega\mu\,(\sigma + i\omega\epsilon)} \qquad \ldots(63)$$

$$\eta = r + ix = \sqrt{\frac{i\omega\mu}{\sigma + i\omega\epsilon}} \qquad \ldots(64)$$

The manipulation of these equations to suit various situations has been well covered in the literature but for ease of reference some general forms are given in Appendix "B". It will be observed that the approximation, which, on the surface may appear to be trivial, in fact causes the mutual inductance M in Figure 6 to vanish (the missing inductive term) yielding a network based on the half-section shown in Figure 1. All the macroscopic anomalies have, therefore, been explained.

34. The correction factor Λ, being a function of ω, converts the Maxwellian propagation function into one which describes a dispersive medium. However, free space (the vacuum) does not apparently display dispersive properties even at the highest frequencies (has anyone ever measured the propagation function for gamma rays?) Therefore, it will be necessary to find the conditions under which Λ is sensibly independent of λ_0, (the reason for identifying λ_0 rather than λ will be obvious at a later stage).

35. Considering only harmonic excitation in the vacuum, we may define:-

$$XY\Delta^2 = \omega^2\mu_0\epsilon_0\Delta^2 = -\left(\frac{\omega\Delta}{c}\right)^2 = -P \qquad \ldots(65)$$

where $c = \frac{1}{\sqrt{\mu_0\epsilon_0}} = f_0\lambda_0$, and $\sqrt{P} = \frac{2\pi\Delta}{\lambda_0}$

hence

$$\Lambda = \frac{\sqrt{1 - (1+2k)P}}{1 - 2kP}$$

and $\qquad \ldots(66)$

$$\lambda_0\frac{d\Lambda}{d\lambda_0} = \frac{\frac{1}{2}(1-2kP)\left[(1+2k)P\right]}{\sqrt{1-(1+2k)P}} - 4kP\sqrt{1-(1+2k)P}$$

all over $\qquad (1-2kP)^2 \qquad \ldots(67)$

Now if P is negligibly small compared with unity and k is a number between 0 and 1:-

$$\lambda_0\frac{d\Lambda}{d\lambda_0} \simeq (1+2k)P - 4kP = 0$$

(zero slope corresponds to λ_0 independence).

35. Continued...

whence, diving by P and solving for k

$$k = \frac{1}{2} \qquad \ldots(68)$$

(hence, eqn. 55 becomes P = 1/2)

It is meaningful to relate this transformer coupling factor to the Fermion spin quantum number 1/2 which is applicable to the electron and positron. There is every reason to believe that k is a constant for each particle, therefore eqn. 66 may be simplified, provided P is negligibly small compared with unity, as follows:-

$$\Lambda = \frac{\sqrt{1 - 2P}}{1 - P} \qquad \ldots(69)$$

From the theory of small numbers, if P is very small

$$\Lambda \simeq \frac{\sqrt{e^{-2P}}}{e^{-P}} = \frac{e^{-P}}{e^{-P}} = 1 \qquad \ldots(70)$$

and clearly, for values of P greater than zero

$$\Lambda < 1$$

36. For the vacuum, the following Maxwellian functions, with subscripts zero, may now be defined.

$$\gamma_0 = i\beta_0 = i\,\frac{2\pi}{\lambda_0} \qquad \ldots(71)$$

$$\eta_0 = \sqrt{\frac{\mu_0}{\epsilon_0}} = 376\cdot7343 \text{ ohms.} \qquad \ldots(72)$$

and from equations 56, 57, 59, 60 and 69.

$$\gamma = \Lambda\gamma_0 = \Lambda\sqrt{XY} = i\Lambda\beta_0 = i\Lambda\frac{2\pi}{\lambda_0} = i\,\frac{2\pi}{\lambda} \qquad \ldots(73)$$

$$\therefore \quad \Lambda\lambda = \lambda_0 \qquad \ldots(74)$$

remembering that Λ is a pure number only very slightly less than unity. $(\lambda > \lambda_0)$.

37. The correction factor Λ, therefore causes the Maxwellian value of wavelength to be very slightly increased and the phase function to be very slightly decreased. Phase velocity is defined as

$$v = \frac{\omega}{\beta} = \frac{2\pi f \lambda}{2\pi} = f\lambda \qquad \ldots(75)$$

and the correction factor, in decreasing β, causes the phase velocity to increase. Moreover, P is an increasing function of ω, for Δ constant (as it turns out to be) so that an increase in ω causes the phase velocity to increase:

$$\frac{dv}{d\omega} > 0 \quad \text{and} \quad \frac{dv}{d\lambda} < 0 \qquad \ldots(76)$$

Group velocity is defined as

$$u = v - \lambda\frac{dv}{d\lambda} \qquad \ldots(77)$$

and by eqn. 76 $\frac{dv}{d\lambda}$ is negative, therefore, $u > v$

Therefore, the vacuum is "anomalously" dispersive, as in the case of conducting media (Ref. 8, pp. 321 to 340 and Ref. 11, pp. 356) and is characterised by the inequality:-

$$u > v > c \qquad \ldots(78)$$

(this is hardly surprising for a Fermi sea of negative energy, negative mass electrons or other smaller charged particles).

38. The frequency response of the network, which has this required low-pass characteristic, has been plotted in Figure 8, in non-dimensional units of propagation function ratio and intrinsic impedance ratio:-

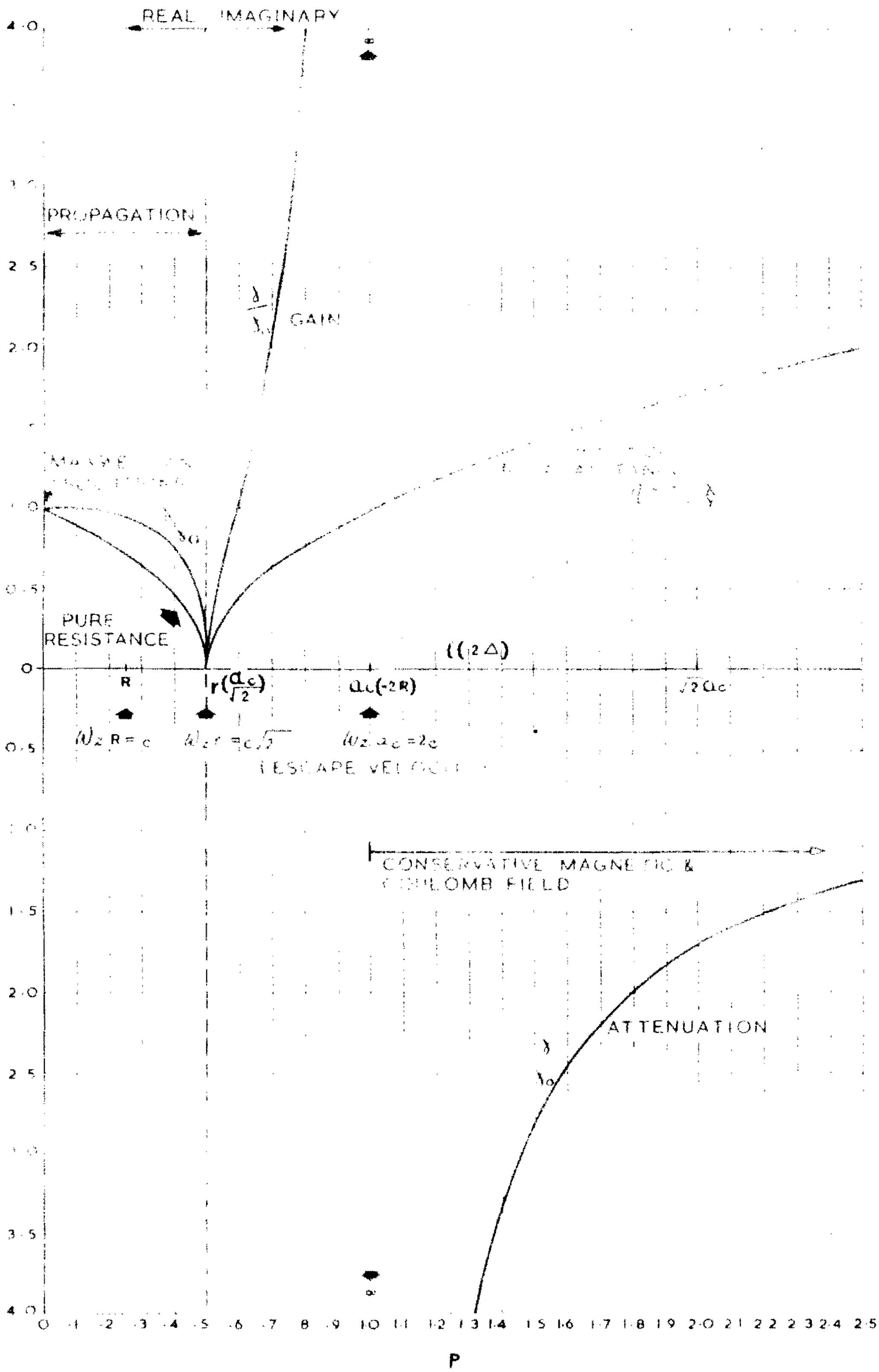
$$\frac{\gamma}{\gamma_0} = \Lambda \quad \text{and} \quad \eta/\eta_0 = (1-P)\Lambda \qquad \ldots(79)$$

It will be noted that the Maxwellian values apply almost at the origin, excluding the case $\omega = 0$, which is the first cut-off criterion. (eqn. 54)

39. The curves of Figure 8, have two interpretations because P is a function of two variables Δ and ω:-

a) For Δ constant at the minimum value determined by the microscopic structure of the vacuum state (yet to be determined) the frequency response of the vacuum is given between the limits P = 0 to 0.5, where $P = \left(\frac{\omega\Delta}{c}\right)^2$ as in equation 65, and all frequencies less than the cut-off frequency $\omega = \frac{c}{\Delta\sqrt{2}}$ can radiate.

fig. 8


REAL
IMAGINARY
PROPAGATION
GAIN
PURE RESISTANCE
ATTENUATION
CONSERVATIVE MAGNETIC & COULOMB FIELD
R
P

39. Continued...

b) For ω constant at the maximum value determined by the ground-state oscillation of the fundamental particle *, the curves represent the field relationships plotted along the radius of the particle, from the centre (P = 0) outwards. The system is conservative.

40. Consider first the cut-off conditions within the electron/positron. The relevant known data for the electron is analysed in Appendix "C" and may be summarized as follows:-

$$\left.\begin{array}{l} M_B = I\pi r^2 \\ M_S = I\pi a^2 \end{array}\right\} \quad \frac{M_S}{M_B} = k_1$$

$$= 1.001161 \pm 0.00001 \qquad \text{...(80)}$$

is the "anomalous" magnetic moment of the electron spin.

$$M_B = \frac{e\hbar}{2m_e c} = \frac{e a_c}{2}$$

is the Bohr Magneton 9.27×10^{-21} erg. gauss^{-1}

and a_c is the Compton radius.

$$\frac{a}{r} = \sqrt{k_1} \qquad \text{...(81)}$$

$$r = \frac{a}{\sqrt{k_1}} = \sqrt{\frac{k_1}{2}} \cdot \frac{1}{\sqrt{k_1}}\, a_c = \frac{a_c}{\sqrt{2}} \qquad \text{...(82)}$$

$$a = \sqrt{\frac{k_1}{2}}\, a_c \qquad \text{...(83)}$$

$$R = \frac{a}{\sqrt{2k_1}} = \frac{a_c}{2} = \frac{r}{\sqrt{2}}$$

is the Radius of Gyration.

...(84)

$$a_c = \frac{\lambda_c}{2\pi} = \frac{\hbar}{m_e c} \qquad \text{...(85)}$$

$$\omega_z = \frac{2 m_e c^2}{\hbar} = \frac{2c}{a_c} \quad \text{and} \quad \lambda_z = \frac{\lambda_c}{2} \qquad \text{...(86)}$$

$$\omega_z R = c \qquad \text{...(87)}$$

*[Footnote: e.g. $\omega_z = \frac{2 m_e c^2}{\hbar}$ is the trembling motion frequency or "Zitterbewegung" (Schrödinger) of the electron/positron derived from the vacuum ionization potential energy (eqn. 1). Other fundamental particles will have frequencies proportional to their masses.]

/21...

40. Continued...

For the circumferential or spin wave, cut-off occurs when:-

$$P = \left(\frac{\omega\Delta}{c}\right)^2 = \frac{1}{2} \quad \ldots(88)$$

On the assumption that $\omega = \omega_z$

$$\Delta = \frac{c}{\omega_z\sqrt{2}} = \frac{a_c}{2\sqrt{2}} = \frac{R}{\sqrt{2}} = \frac{r}{2} \quad \ldots(89)$$

or $\ell = 2\Delta =$ r, is the effective "electrical"radius associated with the Bohr Magenton and is the RMS value of the Compton Radius. Cut-off occurs for the spin wave which has a longer wavelength (λ_z) than has the radial wave. Therefore, the radial wave is in the stop-band and experiences gain. By the use of spherical wave analysis, (Appendix "D") and a comparison of Lorentz Transformations with the transmission line equations, (Appendix "E"), it can be shown that the radial wave cut-off criterion is

$$\Delta = \frac{\lambda_0}{8} \quad \ldots(90)$$

hence

$$\frac{\omega\Delta}{c} = \frac{\omega\lambda_0}{8c} = \frac{\pi}{4}$$

$$\therefore \quad \lambda_0 = 8\Delta = \frac{8a_c}{2\sqrt{2}} = 2\sqrt{2}\,a_c = \frac{\sqrt{2}}{\pi}\lambda_c$$

and $\dfrac{\lambda_0}{\lambda_z} = 2\dfrac{\lambda_0}{\lambda_c} = \dfrac{2\sqrt{2}}{\pi} \simeq 0.90031$ ...(91)

Therefore, when the spin wave is at cut-off the radial wave "phase shift" is

$$\frac{\omega\Delta}{c} = \beta\Delta = \frac{\pi}{4}$$

but

$$\Lambda = \frac{\sqrt{1 - 2\left(\frac{\pi}{4}\right)^2}}{1 - \left(\frac{\pi}{4}\right)^2} \simeq i\,1.2618 \quad \ldots(92)$$

$$\left(\frac{4}{\pi} = 1.27324\right)$$

and

$$\gamma = \frac{\Lambda i 2\pi}{\lambda_0} \simeq (i)^2\frac{8}{\lambda_0} \simeq -\frac{1}{\Delta} \simeq -\alpha \quad \ldots(93)$$

/22...

40. Continued...

which is negative attenuation, or gain as shown in Figure 8.

41. The shortest wavelength that can be generated and radiated by the electron is the Compton wavlength. $\lambda_c = 2\lambda_z$ for electron/positron annihilation gamma rays, therefore:

$$\frac{\omega\Delta}{c} = \frac{1}{2\sqrt{2}}$$

or $$P = \frac{1}{8} \qquad ...(94)$$

whence: $$\Lambda \simeq 0{\cdot}99 \qquad ...(95)$$

so that the propagation and impedance functions approach very nearly to the Maxwellian values. As P decreases with increasing wavelength, Λ rapidly approaches unity. For Δ smaller than $R/\sqrt{2}$ Λ is more nearly equal to unity.

42. However, it is clear that propagation must occur not in a "Fermi sea" consisting solely of negative energy electrons, but also in the "infra-plasma" or aether from which such electrons are constructed. Electrons should, therefore, be considered as a first order vorticity in the infra-plasma (a "vortex sponge" - ref. 1). It is of importance to recall that the theory advanced by Lorentz about 1892, was a theory of "electrons", like those of Weber, Riemann and Clausius, in which all electrodynamical phenomena were ascribed to the agency of moving electric charges, experiencing forces in a magnetic field, proportional to their velocities, and communicating these forces to the "ponderable matter" with which they are associated. The principal feature by which the Lorentz theory differed from the theories of Weber, Riemann and Clausius, and from Lorentz' own earlier work, lay in the conception of propagation of influence between electrons. In the older writings the electrons were assumed to be capable of acting on each other at a distance with forces depending on their charges, mutual distances and velocities, but in his later memoire, the electrons were supposed to interact not directly with each other (force at a distance) but with the medium in which they were embedded. To this medium was ascribed the properties characteristic of Maxwell's aether. It will be called the infra-plasma. (the plasma below the electron structure).

43. At this stage it is of importance to note that the same cut-off criterion can be obtained by means of plasma-wave amplification theory, which is well supported by experimental evidence. (e.g.) Ref. 12 - the electron-wave tube - A.V. Haeff.) Haeff also attributed to this cause the beaming of R.F. energy from the sun, during sun spots and also hitherto unexplained high noise in certain types of radio tubes, including magnetrons. The equation is:

$$\gamma\left(\frac{\bar{v}}{\omega_p}\right) = \pm i\sqrt{\left(\frac{\delta\omega}{\bar{v}\,\omega_p}\right)^2 + 1 \pm\sqrt{4\left(\frac{\delta\omega}{\bar{v}\,\omega_p}\right)^2 + 1}} \qquad ...(96)$$

/23...

43. Continued...

where: $\omega_p \equiv \pm\sqrt{\left|\frac{e}{m}\cdot\frac{d}{\epsilon}\right|}$ is the natural plasma frequency.

$\frac{e}{m}$ = charge-to-mass ratio of plasma particle.

d = average charge density of plasma.

ϵ = dielectric constant of plasma

γ = propagation function.

$\bar{v}$ = arithmetic mean velocity of the two beams.

δ = velocity difference such that $v_a = \bar{v} + \delta$ and $v_b = \bar{v} - \delta$

The cut-off criterion is:

$$\frac{\delta\,\omega}{\bar{v}\,\omega_p} = \sqrt{2} \qquad \ldots(97)$$

and compares with equations 55, 88 and 89. If the Zitterbewegung frequency ω_z is the natural plasma frequency, $\omega = \omega_z$ and eqn. 97 becomes

$$\frac{\delta}{\bar{v}} = \sqrt{2} \qquad \ldots(98)$$

($\bar{v}$ is the RMS value of δ)

But we wish to compare the radial distance with $\ell = 2\Delta$ in Figure 8.

$$\therefore \quad \frac{\omega r}{c} = \frac{\omega \ell}{c} = \frac{2\,\omega\,\Delta}{c} = \sqrt{2} \quad \left(\text{from } 89\right)$$

and this spin velocity at radius $r = \ell = 2\Delta$ is $\sqrt{2}c$, as shown in Figure 8, hence:

$$\frac{\omega r}{c} = \frac{\delta}{\bar{v}} = \sqrt{2} \qquad \ldots(99)$$

44. This natural plasma frequency is also referred to in Ref. 8, Page 327, where Ne = charge density. In the latter reference it is also stated that an electromagnetic wave is propagated in an electron atmosphere without attenuation and with a phase velocity greater than c.

45. The plasma wave theory depends on the existence of differential D.C. plasma velocities V_a and V_b. Therefore, the electron must have differential circulating currents on either side of the radius

/24...

45. Continued...

$r = \frac{a_c}{2}$, or in a suitable frame of reference, counter-rotating currents. This is consistent with the existence of the magnetic dipole moment.

46. It is now necessary to clarify the meaning of the anomalous dispersion (eqn. 78) in relation to the relativistic transformation of the infra-plasma particles. It is generally agreed that the energy is propagated at the group velocity u and that the phase velocity v has nothing to do with propagation except to define the phase relationships of the various parts of the wave. The de Broglie relationship is well covered in the literature (e.g. Ref. 10, page 37) but it refers to a "normally" dispersive medium.

$$E = mc^2 = \frac{m_0 c^2}{\sqrt{1 - \left(\frac{u}{c}\right)^2}} = hf \qquad \ldots(100)$$

yielding the de Broglie result:-

$$mc^2 = hf$$

$$\lambda = \frac{h}{mu}$$

$$v = f\lambda = \left(\frac{mc^2}{h}\right)\left(\frac{h}{mu}\right) = \frac{c^2}{u}$$

whence:-

$$uv = c^2 \qquad \ldots(101)$$

and $$v > c > u \qquad \ldots(102)$$

47. For the "anomalously" dispersive vacuum, the situation is, as sketched in Figure 9, from which it may be deduced that, for uniform energy distribution, the ratio of energies in the two "boxes" (1) and (2) is

$$\frac{E_v}{E_u} = \frac{\ell_v}{\ell_u} = \frac{v}{u} = \frac{hf\lambda}{hf_0\lambda} = \frac{f}{f_0} \qquad \ldots(103)$$

whence, collecting terms from equations 74, 75 and 103 and assuming that

$$v = \sqrt{uc}$$

$$\therefore \quad c = f_0 \lambda_0 \qquad \ldots(104)$$

$$v = f\lambda \qquad \ldots(105)$$

$$u = f_0 \lambda \qquad \ldots(106)$$

/25...

47. Continued...

$$uc = v^2 \qquad \text{...(107)}$$

$$\frac{f}{f_o} = \frac{v}{u} = \frac{c}{v} = \sqrt{\Lambda} \qquad \text{...(108)}$$

$$\lambda_o = \Lambda\lambda \qquad \text{...(109)}$$

and by comparison with the de Broglie analysis it is required that:-

$$mv^2 = hf_o \qquad \text{...(110)}$$

$$\lambda = \frac{h}{mc} \qquad \text{...(111)}$$

$$u = f_o\lambda = \left(\frac{mv^2}{h}\right)\left(\frac{h}{mc}\right) = \frac{v^2}{c} \qquad \text{...(112)}$$

48. The de Broglie analysis must now be re-worked to fit these results, as follows:-

$$E = mc^2 = \frac{m_o c^2}{\sqrt{1-\phi^2}} = hf_o\Lambda = hf\sqrt{\Lambda} \qquad \text{...(113)}$$

is the particle energy: the particle moving at a velocity w

$$\phi = \frac{w}{c} \qquad \text{...(114)}$$

It is now necessary to express the group velocity u in terms of λ_o instead of λ.

$$u = v - \lambda\frac{dv}{d\lambda} = -\lambda^2\frac{df}{d\lambda} = -\left(\frac{\lambda_o}{\Lambda}\right)^2\left(\frac{df}{d\lambda_o}\right)\left(\frac{d\lambda_o}{d\lambda}\right)$$

and $$\frac{d\lambda_o}{d\lambda} = \frac{d(\Lambda\lambda)}{d\lambda} = \Lambda \qquad \text{...(115)}$$

Λ being sensibly independent of λ under the conditions specified in the solution of equation 67 (i.e. $P \ll 1$ and $k = \frac{1}{2}$). Therefore,

$$u = -\frac{\lambda_o^2}{\Lambda}\frac{df}{d\lambda_o} \qquad \text{...(116)}$$

Differentiating 113 w.r.t. λ_o instead of λ

$$\frac{m_o c^2\phi}{(1-\phi^2)^{3/2}}\frac{d\phi}{d\lambda_o} = h\sqrt{\Lambda}\frac{df}{d\lambda_o}$$

but from 116, $$\frac{df}{d\lambda_o} = -\frac{\Lambda u}{\lambda_o^2}$$

$$\therefore \quad \frac{m_o c w}{(1-\phi^2)^{3/2}}\frac{d\phi}{d\lambda_o} = -\frac{h\Lambda^{3/2}u}{\lambda_o^2}$$

/26...

48. **Continued...**

dividing by the velocity w and separating variables

$$m_0 c \int \frac{d\phi}{(1-\phi^2)^{3/2}} = -\frac{h\Lambda^{\frac{3}{2}} U}{w} \int \frac{d\lambda_0}{\lambda_0^2}$$

and integrating

$$\frac{m_0 c\,\phi}{\sqrt{1-\phi^2}} = \frac{h}{\lambda_0} \frac{\Lambda^{\frac{3}{2}} U}{w} \qquad \ldots(117)$$

and the left-hand side is $mc\phi$, from eqn. 113, so that, substituting $\lambda_0 = \Lambda\lambda$.

$$\lambda = \frac{h}{mc}\left(\frac{\sqrt{\Lambda}}{\phi}\frac{U}{w}\right) \qquad \ldots(118)$$

now, from 110 and 108,

$$mv = \frac{hf_0}{v} = \frac{hfU}{v^2} = \frac{hfU}{Uc} = \frac{hf}{c}$$

and $\frac{h}{mc} = \frac{v}{f} = \lambda$

therefore, the required value of w is obtained by setting the bracketted term of 118 to be unity.

$$\frac{\sqrt{\Lambda}\;U}{\phi\;w} = 1 \qquad \ldots(119)$$

Now $\phi = \frac{w}{c}$ and $uc = v^2$, therefore,

$$\sqrt{\Lambda}\,v^2 = w^2$$

but $\sqrt{\Lambda} = \frac{c}{v}$ from 108.

$$\therefore \qquad w = \sqrt{vc} \qquad \ldots(120)$$

$$\text{and } \phi = \frac{w}{c} = \sqrt{\frac{v}{c}} \qquad \ldots(121)$$

Summarizing:

$$\frac{u}{c} = \left(\frac{v}{c}\right)^2 = \left(\frac{w}{c}\right)^4 \qquad \ldots(122)$$

/27...

49. Referring back to equations 110, 111, 112, it will be noted that the propagation wavelength λ is now identified with the de Broglie wavelength of a photon travelling at an effective velocity c but it is also the Compton wavelength of a "particle" whose relativistic mass is m and both m and m_o can be finite. This is a particularly pleasing result in that it frees the de Broglie waves from the stigma of being "different" from "ordinary waves". (Ref. 10, page 38). As will be seen later the ratios (122) are so near unity that, with one notable exception, the differences could remain undectected.

50. This relativistic transformation may be expressed in terms of P.

$$\frac{m_o}{m} = \sqrt{1-\left(\frac{W}{c}\right)^2} = \sqrt{1-\frac{V}{c}} = \sqrt{1-\frac{1}{\sqrt{\Lambda}}} \equiv N \qquad \ldots(123)$$

and $N = i\sqrt{\frac{1}{\sqrt{\Lambda}}-1}$ (N.B. Imaginary mass)

whence, from 69

$$P \simeq (2N)^2 \pm i\,2N \qquad \ldots(124)$$

but N^2 is negative and N is imaginary

$$\therefore P \simeq -\left(2\,|N|\right)^2 \mp 2\,|N|$$

but $|N|^2 \ll |N|$ because $|N|$ is very small

$$\therefore P \simeq \mp 2|N|$$

$$\simeq \mp 2\left|\frac{m_o}{m}\right| \qquad \ldots(125)$$

51. From 122

$$\frac{U}{c} - 1 = \left(\frac{V}{c}\right)^2 - 1 = \left(\frac{W}{c}\right)^4 - 1$$

but

$$\frac{U}{c} - 1 = \frac{U-c}{c} \equiv \frac{V_{s(U)}}{c} = \frac{1}{\Lambda} - 1$$

and $\left(\frac{V}{c}\right)^2 - 1 = \left(\frac{V}{c} - 1\right)\left(\frac{V}{c} + 1\right)$

but $\frac{V}{c} \simeq 1$ and the difference term controls the value towards the limit,

$$\therefore \left(\frac{V}{c}\right)^2 - 1 \simeq 2\left(\frac{V}{c} - 1\right)$$

hence,

$$A = \frac{V_{s(U)}}{c} \simeq 2\,\frac{V_{s(V)}}{c} \simeq 4\,\frac{V_{s(W)}}{c} \qquad \ldots(126)$$

/28...

50. Continued...

where,

$$\left.\begin{aligned} Vs(u) &= u - c \\ Vs(v) &= v - c \\ Vs(w) &= w - c \end{aligned}\right\} \text{are separation velocities.}$$

52. The principle enunciated in 1842, by Christian Doppler (Ref. 1, page 415) is that the motion of a source of "light" relative to an observer modifies the period of the disturbance which is received by him, thus:-

$$\frac{t}{t_o} = \frac{f_o}{f} = \frac{c \pm v_s}{c} \qquad \ldots(127)$$

From 103 and 108: $\frac{f_o}{f} = \frac{U}{V} = \frac{V}{c} = \frac{1}{\sqrt{\Lambda}}$

therefore:

$$c + v_s = v \qquad \ldots(128)$$

and the effective "separation velocity"

$$v_s = v - c = v_{s(v)} \qquad \ldots(129)$$

53. Appendix "F" discusses the controversial subject of Extra—galactic Red Shift and the Expanding Universe postulate. Because there are several independent methods of evaluating P and Λ, which, unfortunately, cannot be included in this short paper, it has been found possible to arrive at the following relationships.

$$A = \frac{V_{s(u)}}{c} = \frac{d}{c\tau} = \frac{\lambda_{ze}}{\lambda_{cg}} \qquad \ldots(130)$$

where:

$d = \lambda_{ze} = \frac{\lambda_{ce}}{2}$ is the Zitterbewegung wavelength.

λ_{ce} = Compton wavelength of the electron $\left(\frac{h}{m_e c}\right)$

$c\tau = \lambda_{cg}$ = Compton wavelength of the graviton $\left(\frac{h}{m_g c}\right)$

or wavelength of Einstein's finite Universe.
$\simeq 1.3 \times 10^{10}$ Light Years.

$\tau = H^{-1}$ is the reciprocal Hubble Constant currently given as approximately 4.133×10^{17} seconds.

$\frac{c\tau}{2\pi} = \frac{2GM}{c^2}$ is the Schwarzschild Singularity.

M = mass of a finite Universe $\simeq 10^{61}$ grm.

but from 122 and 126

$$A = \frac{V_{s(u)}}{c} = \frac{U}{c} - 1 = \frac{1}{\Lambda} - 1$$

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53. Continued...

and from 123

$$-N^2 = \frac{v}{c} - 1 = \frac{v_{s(v)}}{c} = \frac{1}{\sqrt{\Lambda}} - 1$$

therefore, from 126

$$A \simeq -2N^2$$

and $P^2 \simeq 4N^2 \simeq 2A$ ...(131)

i.e.

$$\left(\frac{\omega\Delta}{c}\right)^4 = \left(\frac{2m_o}{m}\right)^2 = \frac{2V_{s(u)}}{c} = \frac{\lambda_{ce}}{\lambda_{cg}} = \left(\frac{h}{m_e c}\right)\left(\frac{m_g c}{h}\right) = \frac{m_g}{m_e}$$

...(132)

where m_e = electron/positron rest mass.

m_g = graviton rest mass.

54. The most accurate determination of P comes from an analysis of all the known particles which yields a pair of equations:

$$\frac{m_1}{m_e} = \frac{n k_4}{2\alpha} \quad ...(133)$$

$$\frac{m_2}{m_e} = \frac{n}{2\alpha k_4} \quad ...(134)$$

where n is an integer or reciprocal integer starting at 1/861 and finishing at 54.

$$k_4 = -\alpha + \sqrt{\alpha^2 + 1} \simeq 0.992,729,334,866...$$

$$\simeq \sqrt{\frac{68}{69}}$$

$\alpha = \dfrac{e^2}{\hbar c}$ is Sommerfeld's Fine Structure Constant

$$\simeq \frac{1}{2\sqrt{68 \times 69}}$$

Two sets of results, based on slightly different derivations of k_4, are given in Tables 1 and 2.

55. It appears from this, that the electron comprises two sub-particles or virtual particles in mutual orbit but in some form of stable oscillatory mode such that, at any instant one of these particles is travelling at the velocity required to yield the relativistic mass known as the electron "rest" mass (m_e) and the other particle is experiencing the combined relativistic transformation involving both the latter factor and P. Because, in the latter, the particle is travelling faster than c it acquires imaginary mass, which behaves

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55. Continued...

like charge. These two virtual particles change places each cycle. The "reduced mass" of these particles is

$$\frac{m}{2} = \frac{m_1 m_2}{m_1 + m_2} = \frac{m_e}{4\pi} \qquad ...(135)$$

yielding

$$P = \frac{m}{2e} = \frac{m_e}{4\pi e} \qquad ...(136)$$

$$= 1.50906 \times 10^{-19}$$

56. The following numerical results are thus obtained

$$P^2 = \frac{m_g}{m_e} = 2.2774 \times 10^{-38} \qquad ...(137)$$

and, assuming that the intermediate particle is the electron neutrino

$$P = \frac{m_{\nu e}}{m_e} = 1.50906 \times 10^{-19}$$

Masses.

$$\left.\begin{array}{lll} \text{Electron neutrino} & = & 1.3745 \times 10^{-46} \text{ grm.} \\ \text{Muon neutrino} & = & (207 \pm 3)\ m_{\nu e} \\ \text{Graviton} & = & 2.0742 \times 10^{-65} \text{ grm.} \end{array}\right\} \qquad ...(138)$$

Electrical Length of Cell.

$$\Delta = 7.1164 \times 10^{-21} \text{ cm.} \qquad ...(139)$$

which should be compared with:-

$$r \simeq 3.3 \times 10^{-22} \text{ cm.}$$

from $\sigma \simeq 11 \times 10^{-44}$ cm.^{2} (proton/anti-neutrino)

as obtained for the electron neutrino in the Savannah River experiment.

57. On theoretical grounds there is reason to believe that the mass of the neutrino should be zero. One of the original arguments for the two-component neutrino theory was that it gives a natural reason for the vanishing of the neutrino mass. There is strong experimental evidence that the mass of the electron neutrino is very small or zero, but there is not such good evidence for the muon neutrino. The best information about the mass of ν_e comes from the measurement of the end point of the tritium beta decay spectrum (Ref. 10, page 356). This yields a limit

$$m_{\nu_e} < 700 \text{ e.v.}$$

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57. Continued...

The two-component theory yields a limit

$$m_{\nu e} < 200 \text{ e.v.}$$

hence

$\frac{m_{\nu e}}{m_e} < 4 \times 10^{-4}$ and could be zero

which is consistent with 1.5×10^{-19} from P, but more accurate experimental evidence is required.

58. Applications of the relativistic transformation for velocity $w > c$ yield mass-to-charge or charge-to-mass transformations. The charge-to-mass ratio of the infra-plasma is the same as that of the electron-positron, therefore, the charge for the electron neutrino is given by the ratio.

$$\frac{e_{\nu e}}{e} = P = 1.50906 \times 10^{-19} \qquad \ldots(140)$$

The present limit for the charge of the electron neutrino is given in the literature as:

$$\frac{e_{\nu e}}{e} \leqslant 10^{-19} \qquad \ldots(141)$$

The infra-plasma, therefore, appears to contain electron neutrinos.

59. Finally, the equations yield a corrected value for Hubble's Constant (reciprocal):

$$\tau = H^{-1} = 3.55376 \times 10^{17} \text{ seconds.} \qquad \ldots(142)$$

compared with the currently accepted value of

$$\tau = 4.133 \times 10^{17} \text{ seconds.} \qquad \ldots(143)$$

but it is necessary to stress that the value of Hubble's Constant has been progressively increased over a number of years and is still possibly inaccurate.

60. The physical interpretation of Extra-Galactic Red Shift does not, therefore, require the Universe to be expanding. It has been shown that an electron spin wave can exhibit the anomalous dispersion required by the propagation function. If all physical forces, electric, magnetic and gravitational, are assumed to arise from the same cause - the momentum impulse derived from the exchange of infra-plasma particles - then there must also be a dynamic explanation of Extra-Galactic Red Shift. Assume a continuous flow of infra-plasma particles (e.g. gravitons) from the eye of each vortexial system, where they are "sucked in" by the "low pressure", to the periphery, impelled by centrifugal force, where they escape after having achieved the required

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60. Continued...

relativistic mass and velocity. (e.g. at P = 1.0 on Figure 8). But escape is only virtual because the system is conservative in that angular momentum and energy cannot both be conserved in this process. Hence, electrostatic, magnetostatic and gravitational conservative fields are explicable. In a manner quite analogous to meson fields, the gravitons can be exchanged between particles whose graviton de Broglie wave fields overlap (a definition of the extent of the Universe). It will, therefore, be assumed that angular momentum must be conserved when gravitons are ejected from electrons/positrons.

61. Angular momentum is

$$I\omega = \frac{m\omega r^2}{2} \qquad \ldots(144)$$

where I is the moment of inertia. It is shown in Appendix C that the mass of the electron is effectively located at the Radius of Gyration $R = \frac{a_c}{2}$ and

$$\omega_z R = c \qquad \ldots(145)$$

Consider, now, another velocity component for the electron rest mass, of magnitude $V_{s(v)}$ which is the separation velocity, directed oppositely to the electron spin angular velocity, such that in the laboratory (Universal) frame of reference the resultant spin velocity is exactly c (eqn. 145). The component of angular momentum associated with this velocity $V_{s(v)}$ will be equated to the angular momentum of the graviton, departing at the "particle" velocity w $= \sqrt{vc}$ as in equation 120. It will be assumed that rotation is of non-slip ("cartwheel") type yielding the velocity/radii relations.

$$\frac{v}{c} = \frac{a}{r}$$

$$\frac{\sqrt{vc}}{c} = \frac{\sqrt{ar}}{r}$$

and the angular momenta may be derived, as follows:-

Graviton.

Rest mass $= m_g$
Angular velocity $= \omega_z = \frac{\sqrt{2}\, c}{r}$ (tentatively)

Radius of gyration $= \sqrt{ar}$

$\therefore$ angular momentum $I_g \omega = \frac{m_g \omega_z a r}{2} = \frac{m_g a c}{\sqrt{2}} \qquad \ldots(146)$

Electron.

Rest mass $= m_e$

Graviton achieves escape velocity and departs at $a_c = 2R = \sqrt{2}\, r$
Tangential separation velocity $= V_{s(v)}$

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61. Continued...

$\therefore$ angular momentum $\quad I_e \omega = \dfrac{m_e r \; V_{s(v)}}{\sqrt{2}}$ ...(147)

By the principle of the conservation of momentum

$$I_e \omega = I_g \omega$$

therefore,

$$\frac{m_g}{m_e} = \left(\frac{r}{a}\right)\left(\frac{V_{s(v)}}{c}\right) \qquad \text{...(148)}$$

but $\quad \frac{r}{a} = \frac{c}{v} \simeq 1$

$$\therefore \quad \frac{m_g}{m_e} \simeq \frac{V_{s(v)}}{c} \simeq \frac{V_{s(v)}}{2c} \simeq \frac{A}{2} \quad ?$$

but from equations 131 and 132,

$$\frac{m_g}{m_e} = P^2 = 2A$$

and in order to correct for this, the graviton must possess a spin exactly 4 times that of the electron, i.e.

Fermions - Spin 1/2

Photons - Spin 1

Gravitons - Spin 2 ...(149)

which is in agreement with Dirac's quantized gravitational field equations.

62. It will, therefore, be seen that recession or the effect hitherto ascribed to an expanding Universe may alternatively be explained in terms of the reactive, negative spin component of the negative energy electrons and electron neutrinos of the vacuum produced by the process of electromagnetic radiation. The exchange particles are either gravitons or some other particles yet to be identified (e.g. "aetherions"). In the step-by-step process of transferring energy in the direction of propagation (Huygen's Principle), assuming a close-packed vacuum state, this negative component of spin velocity will be cumulative, in effect, and the linear increase in <u>apparent</u> separation velocity with distance accords with Hubble's Constant (Appendix "F").

$$V_s = \frac{d}{\tau}$$

where d is an integral number of Compton wavelengths.

63. In the theory of the expanding Universe all wavelengths are doubled when $V_s = c$

$$\frac{2\lambda_0 - \lambda_0}{\lambda_0} = \frac{V_s}{c} = 1$$

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63. Continued...

Presumably, a relative velocity, between two parts of the Universe, greater than the speed of light would be intolerable, and hence the limit of Einstein's finite Universe at a radius $c\tau$. In the new theory, however, this process of run-down in photon frequency and corresponding increase in wavelength, is linearly dependent on distance and can, therefore, continue to the furthest extremity of the Universe. The limit will occur when the wavelength has increased to the graviton wavelength $c\tau$, when the photon will then be absorbed into the gravitational field, provided it has not already been absorbed at some intermediate wavelength in the form of a signal or heat. The expanding Universe theory also claims to explain why the night sky is not a blaze of light from the large number of stars in the Universe. The present theory explains this by the progressive increase in photon wavelength with distance, such that the original light energy from very distant sources arrives at this planet as back-ground cosmic noise energy in the radio-frequency spectrum and below. Unfortunately, it will not be possible to compare the two theories beyond the distance $c\tau$ because violet light will have become infra-red over this distance and, by either theory, the Universe beyond $c\tau$ is invisible (assuming that the original u.v., x-ray and gamma-ray energies are all absorbed long before this). It is indeed a strange coincidence that the visible spectrum is almost exactly 2:1 in wavelength and this is the Red Shift obtained in distance $c\tau$. For the gamma-ray photons, yielded by electron/positron pair annihilation, to run down to the graviton wavelength, a distance is required:-

$$\left(\frac{\lambda_g}{\lambda_{ce}}\right)^2 = \frac{c\tau}{P^2} \simeq 10^{48} \text{ Light Years.} \qquad \ldots(150)$$

64. In conclusion, it has been shown that mass ratios have both real and imaginary roots because relativistic velocities can exceed c. If all forces are assumed to be caused by the momentum impulses produced by the exchange of small particles (Ref. 10, Page 303), although these <u>may</u> not be the same particles for all forces, then one might anticipate the following permutations from $\pm m$ and $\pm im$

(1) Two + m $\quad F_1 = \frac{Gm^2}{r^2}$ (gravitational attraction - positive mass)

(2) Two - m $\quad F_2 = \frac{Gm^2}{r^2}$ (gravitational attraction - negative mass)

(3) One + m, One - m $\quad F_3 = -\frac{Gm^2}{r^2}$ (gravitational repulsion - unlike masses)

(4) Two + im $\quad F_4 = -\frac{m^2}{\epsilon r^2}$ (electric repulsion - two positive charges)

(5) Two - im $\quad F_5 = -\frac{m^2}{\epsilon r^2}$ (electric repulsion - two negative charges)

(6) One + im, One - im $\quad F_6 = \frac{m^2}{\epsilon r^2}$ (electric attraction - unlike charges)

(7) One + m, One + im $\quad F_7 = \frac{im^2}{\mu r^2}$ (Magnetic attraction - spin coupling +)

(8) One + m, One - im $\quad F_8 = -\frac{im^2}{\mu r^2}$ (Magnetic repulsion - spin coupling -)

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64. Continued...

(9) One - m
One + im $\quad F_9 = -\frac{i\,m^2}{\mu r^2}$ (Magnetic repulsion - negative mass)

(10) One - m
One - im $\quad F_{10} = \frac{i\,m^2}{\mu r^2}$ (Magnetic attraction - negative mass)

with appropriate choice of constants to allow for charge/mass ratios and particle masses, this is a comprehensive list of physical forces. It will be noted that electric and magnetic forces are in quadrature, like **E** and **H**.

TRANSMISSION LINE FORM OF MAXWELL'S EQUATIONS

1. Maxwell's equations for a homogeneous, isotropic, medium having no free charge, are:-

$$\nabla \times \mathbf{E} = -\mu \frac{\partial \mathbf{H}}{\partial t} \qquad \ldots(1)$$

$$\nabla \times \mathbf{H} = \left(\sigma + \epsilon \frac{\partial}{\partial t}\right) \mathbf{E} \qquad \ldots(2)$$

$$\nabla \cdot \mathbf{E} = 0 \qquad \ldots(3)$$

$$\nabla \cdot \mathbf{H} = 0 \qquad \ldots(4)$$

2. A plane wave analysis may be used and is in no way restrictive because the linear nature of these equations permits any general field configuration to be produced by the super-position of the requisite number of plane waves, having suitable amplitudes, phase and polarization to suit the boundary conditions. (Ref. 8, pp. 360, 361). For a plane wave aligned with a rectangular co-ordinate system such that, at each instant, the vectors **E** and **H** are constant in direction and magnitude over the x, y planes, the direction of propagation is along the z axis, which also coincides with the unit vector **n**, normal to the wavefront, the plane of constant phase, whence:

$$\nabla = \mathbf{i}\frac{\partial}{\partial x} + \mathbf{j}\frac{\partial}{\partial y} + \mathbf{k}\frac{\partial}{\partial z} = \mathbf{k}\frac{\partial}{\partial z} = \mathbf{n}\frac{\partial}{\partial z} \qquad \ldots(5)$$

3. Therefore, for example,

$$\nabla \times \mathbf{E} = \mathbf{n} \times \frac{\partial \mathbf{E}}{\partial z}$$

but,

$$\frac{\partial}{\partial z}\left(\mathbf{n} \times \mathbf{E}\right) = \frac{\partial \mathbf{n}}{\partial z} \times \mathbf{E} + \mathbf{n} \times \frac{\partial \mathbf{E}}{\partial z}$$

and for the constant $\mathbf{n}$, $\partial \mathbf{n}/\partial z = 0$,

$$\therefore \quad \nabla \times \mathbf{E} = \mathbf{n} \times \frac{\partial \mathbf{E}}{\partial z} = \frac{\partial}{\partial z}\left(\mathbf{n} \times \mathbf{E}\right) = -\mu \frac{\partial \mathbf{H}}{\partial t} \qquad \ldots(6)$$

and

$$\nabla \times \mathbf{H} = \mathbf{n} \times \frac{\partial \mathbf{H}}{\partial z} = \frac{\partial}{\partial z}\left(\mathbf{n} \times \mathbf{H}\right) = \left(\sigma + \epsilon \frac{\partial}{\partial t}\right)\mathbf{E} \qquad \ldots(7)$$

similarly:

$$\nabla \cdot \mathbf{E} = \mathbf{n} \cdot \frac{\partial \mathbf{E}}{\partial z} = \frac{\partial}{\partial z}\left(\mathbf{n} \cdot \mathbf{E}\right) = 0 \qquad \ldots(8)$$

$$\nabla \cdot \mathbf{H} = \mathbf{n} \cdot \frac{\partial \mathbf{H}}{\partial z} = \frac{\partial}{\partial z}\left(\mathbf{n} \cdot \mathbf{H}\right) = 0 \qquad \ldots(9)$$

4. Multiplying both sides of equation 6 vectorially by **n**:

$$\mathbf{n} \times \left(\mathbf{n} \times \frac{\partial \mathbf{E}}{\partial z}\right) = \mathbf{n} \times \left(-\mu \frac{\partial \mathbf{H}}{\partial t}\right) = \mu \frac{\partial \mathbf{H}}{\partial t} \times \mathbf{n}$$

but

$$\frac{\partial}{\partial t}\left(\mathbf{H} \times \mathbf{n}\right) = \frac{\partial \mathbf{H}}{\partial t} \times \mathbf{n} + \mathbf{H} \times \frac{\partial \mathbf{n}}{\partial t}$$

/2...

4. Continued...

and n is independent of t $\therefore$ $\quad \frac{\partial n}{\partial t} = 0$

$$\therefore \quad \frac{\partial}{\partial t}\left(\mathbf{H} \times \mathbf{n}\right) = \frac{\partial \mathbf{H}}{\partial t} \times \mathbf{n}$$

$$\therefore \quad \mathbf{n} \times \left(\mathbf{n} \times \frac{\partial \mathbf{E}}{\partial z}\right) = \mu \frac{\partial \mathbf{H}}{\partial t} \times \mathbf{n} = \mu \frac{\partial}{\partial t}\left(\mathbf{H} \times \mathbf{n}\right) \qquad \ldots(10)$$

5. Expanding the left-hand side of equation 10

$$\mathbf{n} \times \left(\mathbf{n} \times \frac{\partial \mathbf{E}}{\partial z}\right) = \left(\mathbf{n} \cdot \frac{\partial \mathbf{E}}{\partial z}\right)\mathbf{n} - \left(\mathbf{n} \cdot \mathbf{n}\right)\frac{\partial \mathbf{E}}{\partial z}$$

and from equation 8 the first term of the right-hand side is zero

$$\therefore \quad \mathbf{n} \times \left(\mathbf{n} \times \frac{\partial \mathbf{E}}{\partial z}\right) = -\frac{\partial \mathbf{E}}{\partial z} \qquad \ldots(11)$$

and combining 10 and 11

$$\frac{\partial \mathbf{E}}{\partial z} = -\mu \frac{\partial}{\partial t}\left(\mathbf{H} \times \mathbf{n}\right) \qquad \ldots(12)$$

With similar treatment, equation 7 yields

$$\frac{\partial}{\partial z}\left(\mathbf{H} \times \mathbf{n}\right) = -\left(\sigma + \epsilon \frac{\partial}{\partial t}\right)\mathbf{E} \qquad \ldots(13)$$

6. For harmonic excitation $\frac{\partial}{\partial t} = i\omega$ and equations 12 and 13 become

$$\frac{\partial \mathbf{E}}{\partial z} = -i\omega\mu\left(\mathbf{H} \times \mathbf{n}\right) \qquad \ldots(14)$$

$$\frac{\partial}{\partial z}\left(\mathbf{H} \times \mathbf{n}\right) = -\left(\sigma + i\omega\epsilon\right)\mathbf{E} \qquad \ldots(15)$$

which are usually compared with the partial scalar derivatives of the transmission line equations:

$$\frac{\partial V}{\partial z} = -Z\,I \qquad \ldots(16)$$

$$\frac{\partial I}{\partial z} = -Y\,V \qquad \ldots(17)$$

to yield the dubious equivalents:

$$V \sim \mathbf{E} \qquad \ldots(18)$$

$$I \sim \mathbf{H} \times \mathbf{n} \qquad \ldots(19)$$

$$Z \sim 0 + i\omega\mu \qquad \ldots(20)$$

$$Y \sim \sigma + i\omega\epsilon \qquad \ldots(21)$$

APPROXIMATE MACROSCOPIC SOLUTIONS

Equations and Identities.

$$Z_a = kX\Delta + \frac{1}{2Y\Delta} \qquad ...(1)$$

$$Z_b = X\Delta \qquad ...(2)$$

$$\left.\begin{aligned} X &= s\mu && \text{(exponential excitation)} \\ &= \mu\,\partial/\partial t && \text{(differential form)} \\ &= i\omega\mu && \text{(harmonic excitation)} \end{aligned}\right\} \qquad ...(3)$$

$$\left.\begin{aligned} Y &= \sigma + s\epsilon \\ &= \sigma + \epsilon\,\partial/\partial t && \text{"} \qquad \text{"} \\ &= \sigma + i\omega\mu \end{aligned}\right\} \qquad ...(4)$$

$$Z = X \qquad \text{(no real term)} \qquad ...(5)$$

$$\gamma = \sqrt{ZY} = \alpha + i\beta \qquad ...(6)$$

$$\eta = \sqrt{\frac{Z}{Y}} = r + ix \qquad ...(7)$$

$$\gamma\eta = Z \qquad ...(8)$$

$$\frac{\gamma}{\eta} = Y \qquad ...(9)$$

Differential Forms - Line Scalars.

$$\frac{\partial E}{\partial z} = -ZI = -\gamma\eta I \qquad ...(10)$$

$$\frac{\partial I}{\partial z} = -YE = -\gamma/\eta\, E \qquad ...(11)$$

$$\frac{\partial^2 E}{\partial z^2} = -\gamma\eta\frac{\partial I}{\partial z} = \gamma^2 E \qquad ...(12)$$

$$\frac{\partial^2 I}{\partial z^2} = -\gamma/\eta\,\frac{\partial E}{\partial z} = \gamma^2 I \qquad ...(13)$$

Differential Forms - Field Vectors.

$$\frac{\partial \mathbf{E}}{\partial z} = -Z\mathbf{I}^x = -\gamma\eta\mathbf{I}^x \qquad ...(14)$$

$$\frac{\partial \mathbf{I}^x}{\partial z} = -Y\mathbf{E} = -\gamma/\eta\,\mathbf{E} \qquad ...(15)$$

$$\frac{\partial^2 \mathbf{E}}{\partial z^2} = -\gamma\eta\frac{\partial \mathbf{I}^x}{\partial z} = \gamma^2\mathbf{E} \qquad ...(16)$$

$$\frac{\partial^2 \mathbf{I}^x}{\partial z^2} = -\gamma/\eta\,\frac{\partial \mathbf{E}}{\partial z} = \gamma^2\mathbf{I}^x \qquad ...(17)$$

/2...

where $$I^{x} = \int \mathbf{J}^{x}\,dz = \mathbf{H} \times \mathbf{n} \qquad \ldots(18)$$

is the compound current contained in the distance interval dz, which is equivalent to "line current" of the transmission line equations. Therefore, from 15 and 18

$$\frac{\partial I^{x}}{\partial z} = -\, Y\mathbf{E} = -\,\mathbf{J}^{x} \qquad \ldots(19)$$

or

$$\mathbf{J}^{x} = Y\mathbf{E}$$

the generalized form of Ohm's Law for the field, and $\mathbf{J}^{x}$ is the generalized or compound current density.

Point Function Forms.

$$\nabla \times \mathbf{E} = -\, Z\mathbf{H} \qquad \ldots(20)$$

$$\nabla \times \mathbf{H} = Y\mathbf{E} \qquad \ldots(21)$$

Equation 20 refers to a back - e.m.f. or "volts drop" along the "line" caused by the flow of "line current" **H** x **n**, whereas 21 refers to a driving function or forward e.m.f. producing a flow of current density $\mathbf{J}^{x}$. These are generalized forms of Ohm's Law for time-varying fields and may be represented in scalar form as

$$\mathcal{E} = -\, Z I \qquad \ldots(22)$$

$$J^{x} = Y E \qquad \ldots(23)$$

ELECTRON/POSITRON EQUATIONS

1. Applying Bohr's first postulate to the spin angular momentum of the electron (Uhlenbech and Goudsmit - 1925)

$$p = \pm \frac{\hbar}{2} \quad \text{erg. sec.} \qquad \ldots(1)$$

and the spin magnetic moment is

$$M_s = k_1 M_B \qquad \ldots(2)$$

where $M_B = \frac{e\hbar}{2m_e c} = \frac{e a_c}{2}$ is the Bohr Magneton

$= 9.27 \times 10^{-21}$ erg/gauss

$a_c = \frac{\hbar}{m_e c}$ is the Compton Radius $\lambda_c / 2\pi$

and $k_1 = \frac{M_s}{M_B} = \left[1 + \frac{\alpha}{2\pi} - 0.328\frac{\alpha^2}{\pi^2} + \ldots\right]$

$= 1.001161 \pm 0.00001$

$\alpha = \frac{e^2}{\hbar c}$ is Sommerfeld's Fine Structure Constant.

$$\therefore \quad M_s = \frac{k_1 e a_c}{2} \qquad \ldots(3)$$

2. However, a second expression for the electron spin magnetic moment can be derived from first principles. Let the electron charge be confined to a circular line source spinning at a radius r = a, then the quantity of charge passing a given point in unit time is the effective current:

$$I = \frac{n\bar{e}}{t} = \frac{e}{t} = ef = \frac{ev}{2\pi a} = \frac{e\omega a}{2\pi a} = \frac{e\omega}{2\pi} \qquad \ldots(4) \ (\text{e.s.u.})$$

(where t is the period of one orbit)
noting the important fact that the current I is independent of radius.

Now expressing I in e.m.u. and leaving e in e.s.u. in order to be compatible with the previous equations:

$$I = \frac{e\omega}{2\pi c} \qquad \ldots(5)$$

but, by definition (e.g. Ref. 11, page 160) the magnetic moment of a current loop, irrespective of its shape, is

$$M = IA \qquad \ldots(6)$$

$$\therefore \quad M_s = IA = I\pi a^2 = \frac{e\omega a^2}{2c} = \frac{eva}{2c} \qquad \ldots(7)$$

/2...

2. Continued...

Equations 3 and 7 may now be combined:

$$\frac{e\omega a^2}{2c} = \frac{k_1 e\hbar}{2 m_e c}$$

$$\therefore \quad \omega a^2 = \frac{k_1 \hbar}{m_e} \qquad \ldots(8)$$

As a check on dimensions

$$|\omega a^2| = |va| = \left|\frac{L^2}{T}\right|$$

$$|\hbar| = \text{energy} \times \text{time} = \left|\frac{ML^2}{T}\right|$$

$$\therefore \left|\frac{\hbar}{m_e}\right| = \left|\frac{L^2}{T}\right|$$

and it is clear that 8 may be used in e.s.u. or e.m.u. because e has been eliminated.

3. It is most significant that 8 is a classical kinematic equation and the right-hand side is a constant. Ignoring k_1

$$\frac{\hbar}{m_e} = 1{\cdot}157{,}662{,}67 \quad cm^2\, sec^{-1} \qquad \ldots(9)$$

which is an area per second constant, and immediately we are reminded of the Areal Velocity Law of Johannes Kepler (1609) - the constant rate at which the area of a planetary orbit is swept out by the radius vector. The electron is a small planetary system.

4. Now $v = \omega a$ is the orbital velocity within the torrus and, from 8

$$a = \frac{k_1 \hbar}{m_e v} \qquad \ldots(10)$$

The zero point energy of a quantum-mechanical harmonic oscillator is (Ref. 10, page 151)

$$E_0 = \frac{\hbar\omega}{2} \qquad \ldots(11)$$

and by equating this to the rest mass energy of the electron we obtain

$$\omega_z = \frac{2 m_e c^2}{\hbar} = \frac{2c}{a_c} \qquad \ldots(12)$$

which is the "Zitterbewegung" or trembling motion frequency of the free electron first studied by Schrödinger using Dirac's relativistic quantum-mechanical wave equations for the electron.

/3...

4. Continued...

Now combining equations 8 and 12 to eliminate m_e

$$v^2 = (\omega a)^2 = 2k_1 c^2$$

$$\text{or} \qquad v = \pm\sqrt{2k_1}\; c \qquad \ldots(13)$$

noting that $c \simeq (R.M.S.)\, v$

and combining 10 and 13

$$a = \frac{k_1}{\sqrt{2k_1}} \cdot \frac{\hbar}{m_e c} = \sqrt{\frac{k_1}{2}}\; a_c \qquad \ldots(14)$$

5. Now, from 2

$$M_B = \frac{e\, a_c}{2}$$

and it is clear that this magnetic moment is produced by the same charge that produces Ms, also that the effective current I is independent of radius. Therefore, assigning a radius r to M_B as in 7.

$$M_B = \frac{e\hbar}{2m_e c} = \frac{e\, a_c}{2} = I\pi r^2 = \frac{e\omega r^2}{2c} \qquad \ldots(15)$$

but $M_s / M_B = k_1$

$$\therefore \qquad \left(\frac{a}{r}\right)^2 = k_1$$

$$\text{or} \qquad r = \frac{a}{\sqrt{k_1}} \qquad \ldots(16)$$

and from 14,

$$a = \sqrt{\frac{k_1}{2}}\; a_c$$

$$\therefore \quad r = \sqrt{\frac{k_1}{2}} \cdot \frac{1}{\sqrt{k_1}} \cdot a_c = \frac{a_c}{\sqrt{2}} \qquad \ldots(17)$$

in other words, r is the RMS value of the radius for which the Compton Radius is the maximum value. This confirms that there are both radial and circumferential standing waves.

6. As shown in the literature (e.g. Ref. 10, pp. 54, 80) the magneto-gyric ratio (more frequently, incorrectly called the gyromagnetic ratio) for the electron spin, which is approximately twice that for atomic orbital motion, is given by combining eqns. 1 and 3.

$$\gamma_e = \frac{M_s}{p} = \frac{k_1 e}{m_e c} \qquad \ldots(18)$$

/4...

6. Continued...

as given by Dirac's relativistic quantum theory. The "anomalous" magnetic moment" correction factor k_1 was shown to be necessary by P. Kusch and H. M. Foley (1947) and by S. H. Koenig, A. G. Prodell and P. Kusch ,1952). However, the factor of 2 difference between spin and orbital ratios follows at once from the present analysis. From 1, 7 and 8.

$$p = I_m \omega = \frac{M_s}{\gamma_e} = \left(\frac{e\omega a^2}{2c}\right)\left(\frac{m_e c}{k_1 e}\right) = \frac{m_e \omega a^2}{2k_1} = \frac{\hbar}{2} \qquad ...(19)$$

where

$$I_m = \frac{p}{\omega} = \frac{m_e a^2}{2k_1} = m_e R^2 \qquad ...(20)$$

and

$$R = \frac{a}{\sqrt{2k_1}} \qquad ...(21)$$

is the Radius of Gyration - the radius at which the total mass would have to be concentrated in order to yield the same moment of inertia Im.

Combining 14 and 21

$$R = \sqrt{\frac{k_1}{2}} \cdot \frac{1}{\sqrt{2k_1}} \cdot a_c = \frac{a_c}{2} \qquad ...(22)$$

is exactly half the Compton Radius. Therefore, from 12 and 22

$$\omega_2 R = c$$

(constant) ...(23)

and this might be taken as the definition of the so-called "speed of light".

7. When an electron/positron pair annihilate, two gammaray photons are produced which depart in opposite directions. The energy of each photon is $m_e c^2$ because the ionization energy is $2m_e c^2$, but a photon is a Boson (obeys Bose-Einstein statistics - spin $1\hbar$) therefore, its de Broglie wavelength is

$$\lambda = \frac{h}{m_e c} \qquad ...(24)$$

obtained from $m_e c^2 = \hbar\omega = \cancel{hc}/\lambda$

$$\therefore \qquad \lambda = \frac{h}{m_e c} = \lambda_c \qquad ...(25)$$

which is both the Compton Wavelength and the de Broglie wavelength of the "particle" or photon. This suggests, that at the instant of departure from the electron the effective radius of the charge torrus is the Compton Radius (a_c). Hence, the "escape velocity to infinity" from the electron is

/5...

7. <u>Continued...</u>

$$v = \omega_z a_c = 2\omega_z R = 2c \qquad \text{...(26)}$$

This checks with equation 17 that the Compton Radius is the maximum value of radius for which the RMS value is r and is consistent with the existence of both radial and spin standing waves. It can also be shown that the escape velocity coincides with the cancellation of the electrostatic attractive force between outer torrus and nucleus by the magnetic repulsive force generated by two equal and opposite currents, but this rather lengthy analysis is beyond the scope of this short paper.

Clearly, in order that two photons shall be able to depart in opposite directions at the "speed of light" in the laboratory frame of reference, it is necessary that their relative separation velocity shall be 2c at the instant of electron/positron annihilation. This suggests a reason why photons are Bosons instead of Fermions.

SPHERICAL WAVES

1. There are various approaches to the determination of a standing-wave system applicable to the aether. Perhaps the simplest approach which yields a first order solution is given by a spherical wave analysis. That this is justified as an approximation is demonstrated by the Liquid Drop Model for atomic nuclei (Ref. 10, page 296).

2. The electric and magnetic dipole and multipole moments of nuclei are quantized. In particular, the electric quadrupole moment is intimately related to the nuclear form factor. The quadrupole moment is zero for spherical symmetry. For a prolate ellipsoid of revolution (equatorial radius smaller than polar radius) the nuclear electric quadrupole moment is positive, whereas a negative moment corresponds to an oblate ellipsoid.

3. In what follows, the medium is the aether or infra-plasma, out of which the electrons are created by vorticity. Consider a homogeneous, isotropic sphere of radius "a" embedded in a homogeneous, isotropic medium of infinite extent. Considering only the electric modes, the field has a radial component of E and the magnetic vector is always perpendicular to the radius vector. (Ref. 8, page 554). Therefore, there must be a distribution of electric charge on the surface of the sphere to yield the correct boundary condition. The transcendental equation is:

$$\frac{\left[N\theta j_n(N\theta)\right]'}{N^2 j_n(N\theta)} = \frac{\mu_2}{\mu_1}\,\frac{\left[\theta h_n^{(1)}(\theta)\right]'}{h_n^{(1)}(\theta)} \qquad \ldots(1)$$

where

$\theta = \gamma_2 a$

$N = \gamma_1/\gamma_2$

γ_1 = propagation function for the sphere.
γ_2 = propagation function for surrounding medium.

4. Now, setting aside the problem of excitation, consider the rather unusual situation when $\gamma_1 = \gamma_2$. The sphere is now simply a surface defined mathematically by the radius, but there is no physical interface (ignoring the surface charge). Equation 1 becomes:

$$\frac{\left[\theta j_n(\theta)\right]'}{j_n(\theta)} = \frac{\left[\theta h_n^{(1)}(\theta)\right]'}{h_n^{(1)}(\theta)} \qquad \ldots(2)$$

/2...

5. Interest is confined to the first order electric mode for $n = 1$ so that the half order spherical Bessel functions become:

$$P_n + \tfrac{1}{2}(\theta) = 1$$

(there is a term n^2-1 in the numerator of all other terms)

$$Q_n + \tfrac{1}{2}(\theta) = \frac{1}{\theta}$$

so that

$$h_1^{(1)}(\theta) = -\frac{1}{\theta}\left[1 + \frac{i}{\theta}\right]e^{i\theta} \qquad \ldots(3)$$

$$\left[\theta h_1^{(1)}(\theta)\right]' = -\frac{i}{\theta^2}\left[\theta^2 + i\theta - 1\right]e^{i\theta} \qquad \ldots(4)$$

whence, the right-hand side of equation 2 becomes

$$\frac{i\theta^2 - \theta - i}{\theta + i} \qquad \ldots(5)$$

6. From the general expression for the integral Bessel Function $j_n(\theta)$

$$\theta j_1(\theta) = \left[\cos(\theta - \pi) - \frac{1}{\theta}\sin(\theta - \pi)\right]$$

$$\frac{[\theta j_1(\theta)]'}{j_1(\theta)} = \frac{\left[1 + \frac{1}{\theta^2}\right]\sin(\theta - \pi) - \frac{1}{\theta}\cos(\theta - \pi)}{\frac{\cos(\theta - \pi)}{\theta} - \frac{1}{\theta^2}\sin(\theta - \pi)} \qquad \ldots(6)$$

but

$$\sin(\theta - \pi) = -\sin\theta$$
$$\cos(\theta - \pi) = -\cos\theta$$

yielding, as a final solution of equation 2 for $n = 1$

$$\frac{(\theta^2 + 1)\tan\theta - \theta}{\theta - \tan\theta} = \frac{i\theta^2 - \theta - i}{\theta + i} \qquad \ldots(7)$$

which simplifies to:

$$\tan\theta = \frac{i\theta}{\theta + 2i} \qquad \ldots(8)$$

/3...

7. For a lossless medium like the vacuum

$$\gamma = -i\beta$$

(negative going wave)

and $\tan(-i\beta a) = \dfrac{i\beta a}{(2-\beta a)}$

but $\tan(-i\beta a) = i\tanh \beta a$

$$\therefore \tanh \beta a = \frac{\beta a}{2-\beta a} \qquad \ldots(9)$$

with solution by computer,

$$\beta a = 0.796{,}812{,}130 \qquad \ldots(10)$$

It will be seen that the phase shift at the surface of the sphere is somewhat greater than $\frac{\pi}{4} = 0.78540$. The ratio is

$$\frac{4\beta a}{\pi} = 1.0146 \qquad \ldots(11)$$

By definition, $\beta = 2\pi/\lambda$ therefore

$$a \simeq \lambda/8 \qquad \ldots(12)$$

which checks with the value for Δ in Appendix "E".

LORENTZ TRANSFORMATION AND THE TRANSMISSION LINE EQUATIONS

1. Lorentz is stated to be the first to show that Maxwell's equations are invariant under hyperbolic transformation

$$z^2 - (ct)^2 = 1 \qquad \ldots(1)$$

but not under Galilean transformation

$$\left.\begin{aligned} z' &= z - vt \\ t' &= t \end{aligned}\right\} \qquad \ldots(2)$$

This is not strictly true because the transformation in question had been applied to the equation of vibratory motion many years before by Voigt (Gött. Nach. 1887 page 41).

2. In the present analysis it is a basic postulate that electromagnetic propagation must be capable of representation by an exact formulation of a transmission network derived from an adequate equivalent circuit analysis. It should, therefore, be possible to obtain correlation between the transmission line equations and the Lorentz transformations.

3. It is sometimes overlooked that the theory advanced by Lorentz from 1892 onwards was, like those theories of Weber, Riemann and Clausius, a theory of "electrons". That is to say, all electrodynamical phenomena are ascribed to the agency of moving electric charges which are supposed to experience forces in a magnetic field proportional to their velocities and to communicate these forces to the "ponderable matter" with which they are associated. The principal feature by which the Lorentz theory differed from the theories of Weber, Riemann and Clausius and from Lorentz' own earlier work, lies in the conception of propagation of influence between electrons. In the older writings, the electrons were assumed to be capable of acting on each other at a distance with forces depending on their charges, mutual distances and velocities, but in his later memoire the electrons were supposed to interact, not directly with each other, but with the medium in which they are embedded. To this medium was ascribed the properties characteristic of Maxwell's aether.

4. Lorentz first attempted to employ a Galilean transformation which had to neglect quantities of higher order than the first in v/c. After this, Lorentz developed a transformation which is exact to all values of the quantity v/c. This theory is well described in the literature and with particular clarity in Ref. 1, page 440 onwards.

5. The transformation is based simply on the equation of the rectangular hyperbola (eqn. 1) which, in the plane of the variables z and t, remains unaltered when any pair of conjugate diameters is taken as new axes and a new unit of length is taken proportional to the length of either of these diameters. The equations of transformation are thus found to be

/2...

5. Continued...

$$z_1 = z_2 \cosh\theta + c t_2 \sinh\theta \qquad ...(3)$$

$$t_1 = t_2 \cosh\theta + \frac{z_2}{c} \sinh\theta \qquad ...(4)$$

$$(y_1 = y_2\,,\; x_1 = x_2)$$

where θ is a constant which will be written as $\gamma\Delta$,

The simpler equations previously given by Lorentz may be derived from these by writing v/c for tanh θ and by neglecting powers of v/c above the first.

6. The formal similarity between these equations and the hyperbolic form of the transmission line equations demands attention:

$$E_1 = E_2 \cosh\theta + I_2 Z_0 \sinh\theta \qquad ...(5)$$

$$I_1 = I_2 \cosh\theta + \frac{E_2}{Z_0} \sinh\theta \qquad ...(6)$$

and to create identities the following relationships must hold:-

$E = z$ (electric field $\equiv$ distance) ...(7)

$I = t$ (electric current $\equiv$ time) ...(8)

$Z_0 = c$ (characteristic impedance $\equiv$ velocity of light) ...(9)

expressing (7) and (8) as ratios:-

$$\frac{E}{I} = \frac{z}{t} = v \quad \text{(a velocity)} \qquad ...(10)$$

but, from network theory, under image-matched conditions:-

$$\frac{E_1}{I_1} = Z_1 = \frac{E_2}{I_2} = Z_2 = Z_0 \qquad ...(11)$$

and combining this with (9),

$$Z_0 = v = c \qquad ...(12)$$

This indicates that the source of electromagnetic energy (particle or photon) is always travelling at an average velocity equal to the "speed of light". (vide Einstein's second postulate).

7. For free space, the relationship 9 yields:-

$$Z_0 = \sqrt{\frac{\mu_0}{\epsilon_0}} = c = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$$

$$\therefore \quad \left.\begin{array}{l} \mu_0 = 1 \\ \epsilon_0 = 1/c^2 \end{array}\right\} \qquad ...(13)$$

which result is only valid in Electromagnetic Units (e.m.u.) and these results indicate that the source of radiation is a charged particle,

/3...

7. Continued...

travelling at the speed of light. This means that there is no such thing as electrostatic charge. The force produced by what is believed to be a static charge in e.s.u. is, therefore, in fact the force produced by a charge moving at the speed of light, i.e.

$$e = c e' \qquad \ldots(14)$$

where e = charge in e.s.u.
e' = charge in e.m.u.

and this factual relationship is now explicable.

8. How can this be explained in a given frame of reference, when charge appears to be stationary when subjected to macroscopic measurements? There is only one satisfactory explanation - the charge is spinning at a very small radius at the speed of light. This spinning charge constitutes a current and the magnetic moment of the electron is proof of its existence. Hence:

$$\phi = \frac{v}{c} = i \qquad \ldots(15)$$

because the direction of motion of charge is always at right angles to the macroscopic direction of propagation. From equations (3) and (4)

$$\sinh\theta = \frac{\phi}{\sqrt{1-\phi^2}} \qquad \ldots(16)$$

$$\cosh\theta = \frac{1}{\sqrt{1-\phi^2}} \qquad \ldots(17)$$

$$\tanh\theta = \phi = i \qquad \ldots(18)$$

whence, in vacuum $\theta = \gamma\Delta = i\beta\Delta$ ...(19)

but $\tanh ix = i\tan x$ (in general)

$$\therefore \tan\beta\Delta = 1$$
$$\text{and} \quad \beta\Delta = \frac{\pi}{4} \qquad \ldots(20)$$

$$\therefore \Delta = \left(\frac{\pi}{4}\right)\left(\frac{\lambda}{2\pi}\right) = \frac{\lambda}{8} \qquad \ldots(21)$$

where Δ is the abbreviation for Δz, an elemental length in the direction of propagation,

and $$\ell = 2\Delta = \frac{\lambda}{4} \qquad \ldots(22)$$

/4...

9. In summary, the propagation along a transmission line takes place in the field surrounding the lines, the waves within the wires themselves representing a component of loss. This propagation consists of continuously repeated transformations of the Lorentz form, from the laboratory frame of reference to microscopic spinning systems (particles) and the reverse process. The peripheral velocity of the spinning system is equal to the "speed of light". In other words:- transmission is transformation.

10. It is of considerable interest to record that at the time the author derived this relationship (1960-61) while in the U.S.A., a colleague, Mr. S. R. Deards at the College of Aeronautics, Cranfield, Bedford, also found the same type of relationship in studying a linear resistance 2-port. This is reported in a C of A Internal Technical Note - dated 11th April, 1961.

EXTRA-GALACTIC RED SHIFT

1. A detailed study shows that the displacement of nebular spectra in general consist of two sets of displacements superimposed:-

a) Random displacements in either direction.

b) Systematic displacements which are invariably towards the red end of the spectrum.

The random displacements indicate random motion, half the nebulae, on average, advancing towards us and half receding from us. At a distance of a few million light years these random displacements become insignificant compared with the systematic displacement towards the red. Humason and Hubble discovered the remarkable law, known as Hubble's Law, that the amount of systematic displacement is proportional to the distance separating the nebula and the observer. The law is so exact that it provides the most reliable method for estimating the distance of the most remote nebulae. Whether the systematic displacement is really caused by a motion of recession or separation is unknown, although most cosmologists have now accepted this postulate. (The association of the causes of the random and systematic displacements has a powerful effect on deductions:) If this is true, these recession velocities are remarkably large in the case of those nebulae which are at the limits of observation. Velocities which are appreciable fractions of the speed of light are now being ascribed to newly discovered nebulae as more powerful telescopes become available.

2. However, many doubts have been expressed as to the validity of the explanation of recession and the expanding Universe (Ref. 13). Many cosmologists and physicists accept the fact that some other mechanism could account for this effect - some mechanism which classical electromagnetic theory fails to disclose; like its failure to disclose the particle structure of the Universe. Such a mechanism is now at our disposal. The new theory is, therefore, submitted as providing, inter alia, an alternative to the theory of the expanding Universe for explaining extra-galactic red shift.

3. The recession theory is based on the Doppler effect (Christiaan Doppler, 1842) whereby a source moving relative to an observer produces an effective change in the period of the signal given by:

$$\frac{t}{t_o} = \frac{c \pm v_s}{c} \qquad \ldots(1)$$

but $f_o \lambda_o = c$ and $E = hf$ in general

$\therefore$

$$\frac{E_v}{E_\upsilon} = \frac{v}{\upsilon} = \frac{hf}{hf_o} = \frac{f}{f_o} = \frac{t_o}{t} = \frac{c}{v} = \sqrt{\Lambda} \qquad \ldots(2)$$

where v = phase velocity
υ = group velocity

3. Continued...

whence $v = c + v_s$ (in this case)

and the apparent separation velocity is

$$v_s = v - c = v_{s(v)} \qquad ...(3)$$

as derived from the analysis in the body of this paper.

4. Hubble's Constant which, unfortunately, has varied appreciably over the years, is currently quoted as about 75 kilometres per second per million parsecs (1 parsec = 3.263 Light Years and 1 L.Y. = 9.5×10^{12} kilometres). This yields a reciprocal Hubble Constant.

$$\tau = H^{-1} = 4.133 \times 10^{17} \text{ seconds} \qquad ...(4)$$

and $$\tau = \frac{\text{distance}}{\text{apparent recession velocity}} = \frac{d}{v_s} \qquad ...(5)$$

This constant is measured over a wide range of wavelengths and it is known that

$$\frac{d\lambda}{\lambda} = \text{constant (for a given distance)} \qquad ...(6)$$

for all wavelengths, including radio wavelengths. Hence the requirement:

$$\frac{\lambda - \lambda_o}{\lambda_o} = \frac{v_s}{c} \quad \text{constant (for a given distance)} \qquad ...(7)$$

where $$v_s = \frac{d}{\tau}$$

Multiplying top and bottom of equation 7 by f_o yields

$$\frac{f_o\lambda - f_o\lambda_o}{f_o\lambda_o} = \frac{u - c}{c} = \frac{v_{s(u)}}{c} = \frac{1}{\Lambda} - 1 \qquad ...(8)$$

5. Now if Vs(u), Vs(v) and τ are constants, the distance d must also be a constant. What is it? Over what distance must a comparison be made between the two competing theories? What is the apparent recession velocity v - c in terms of the physical reality of the infra-plasma? It is necessary to think somewhat differently about distant sources. From the electrical engineering point of view it is always assumed that the frequency of the current and voltage at all points of a network is uniquely determined by the frequency of the primary generator connected to it. Perhaps by inference it has also been assumed that, in general, the frequency of "light" or other radiation is determined by the original signal source for all time and all space. Is this valid? It is known that many of the original sources of light, now being received, may no longer exist. Some, in fact, disintegrated long before

/3...

5. Continued...

this planet was formed. What controls the frequency of an expanding sphere of light waves after the original sources cease to exist? What is the frequency standard built into a light wave or photon? The answer to this question was provided by Christiaan Huygens (1629 - 1645).

6. Huygen's principle may be stated as follows:-

(Ref. 1) - "Consider a wave-front or locus of disturbance as it exists at a definite instant t_0, then each surface element of the wavefront may be regarded as the source of a secondary wave, which, in a homogeneous, isotropic, medium will be propagated outwards from the source or surface element in the form of a sphere whose radius at any subsequent instant t is proportional to $t - t_0$ and the wavefront which represents the whole disturbance at the instant t is simply the envelope of all the secondary waves which arise from the various surface elements of the original wave front". The introduction of this principle enabled Huygens to succeed where contemporary wave theorists had failed in achieving the explanation of refraction and reflection. This was later fully justified by Fresnell.

7. The wavefront is, therefore, continually re-born as it progresses and the memory exists only in the aether, vacuum, or infra-plasma which conveys it. If, as this analysis suggests, the vacuum is dispersive (if only very slightly) then the photon "runs down" in frequency and increases its wavelength as it progresses in a manner only dependent on the distance covered. This process can continue without limit and is a linear function of distance, unlike the expanding Universe theory, which could not, presumably, countenance a recession velocity greater than the velocity of light c.

8. The limit to which the run-down process continues is the wavelength of the smallest particle in the Universe $\left(\lambda = h/mc\right)$ which is assumed to be the graviton, subject, of course, to confirmation. At this stage the remaining energy is coupled back into the vacuum state, but the original photon may fail to reach this limit by being absorbed at some higher frequency. Hence there is a continuous energy circulation.

9. The present theory explains why the night sky is not a blaze of light from all the stars in the Universe because the original light photons eventually "run down" to the radio frequency spectrum and below, as cosmic noise energy.

ELECTRON/MUON AND ELECTRON/MUON NEUTRINOS RELATIONSHIPS

1. Throughout this study the natural frequency of the infra-plasma has been associated with the Zitterbewegung frequency of the electron (ω_z). In fact the electron/positron are the result of the dispersive resonance in the infra-plasma (the centre frequency of the dispersion and absorption curves - e.g. Ref. 8, pages 325, 327). It is, therefore, desirable to clarify the relationship between electrons and u-mesons (muons), also the similar relationship between the electron neutrino and the muon neutrino. Apart from a single quantum which serves to distinguish between ν_e and ν_μ , present knowledge is consistent with the assumption that all properties of these two particles are the same. Such apparent duplication is as mysterious here as it is in the familiar case of electron and muon (Ref. 14).

2. The Pauli Exclusion Principle, governing the group behaviour of all elementary particles possessing spin $\frac{1}{2}\hbar$ (Fermions) has an important effect on the behaviour of a group of particles confined in a limited volume such as an atom, crystal or plasma. Such an assembly is often called a particle "sea" or "gas", but because of the exclusion principle, its properties are quite different in many respects from those of an ordinary gas. Consider a group of N particles occupying a volume V. On average each particle will occupy a volume V/N and in order to be confined to a region of this size it is necessary that the particle's de Broglie wave-packet be of this order in dimensions, namely

$$\lambda \simeq \left(\frac{V}{N}\right)^{\frac{1}{3}} \qquad \ldots(1)$$

thus the average momenta of the particles will be about

$$\bar{p} \simeq h\left(\frac{N}{V}\right)^{\frac{1}{3}} \qquad \ldots(2)$$

which corresponds to an average kinetic energy of

$$\bar{E}_K = \frac{\bar{p}^2}{2m} \simeq \frac{h^2}{2m}\left(\frac{N}{V}\right)^{\frac{2}{3}} \qquad \ldots(3)$$

and this shows that, because of the finite value of h , any attempt to increase the density of such a plasma either by increasing N or by reducing V will result in the raising of energy and momentum of the particles.

3. For particles travelling at approximately the speed of light with respect to the laboratory frame of reference, the particle appears as a polarized disc in virtue of Lorentz contraction (Ref. 10, p. 228 - Schwinger radiation) so that the volume available for the de Broglie wave-packet is cylindrical instead of spherical. The mean free path is

$$\ell = \frac{1}{\left(\frac{N}{V}\right)\pi r^2} \qquad \ldots(4)$$

/2...

3. Continued...

where r = collision radius,

and the de Broglie wave has two degrees of freedom:-

a) Axially - a straight path length $\ell = \lambda_c$

b) Circumferentially - half the circumference by diffraction resulting from normal incidence - $\lambda_c = \pi r$

$$\therefore \pi r^2 \ell = \frac{\pi \lambda_c^3}{\pi^2} = \frac{\lambda_c^3}{\pi} = \frac{V}{N} \qquad \ldots(5)$$

4. The equation for the natural plasma frequency ω_p as given in Ref. 12, and Ref. 8, page 327, can be re-written in the form

$$\omega_p^2 = \omega_z^2 = \left(\frac{N}{V}\right)\frac{e^2}{m_o \epsilon} \qquad \ldots(6)$$

where ϵ = dielectric constant ($\epsilon = 1$ in e.s.u.)

$\frac{Ne}{V}$ = charge density

Eliminating $\frac{V}{N}$ between 5 and 6

$$\frac{\lambda_{co}^3}{\pi} = \frac{e^2 \hbar^2}{m_o\, 4\, m_e^2 c^4} \qquad \ldots(7)$$

where λ_{co} is the de Broglie/Compton wavelength of the plasma particle whose mass is m_o

$$\lambda_{co} = \frac{h}{m_o c} \qquad \ldots(8)$$

but

$\left(\frac{e^2}{m_o c^2}\right) = r_o$ is the Classical radius of the particle

$\left(\frac{\hbar}{m_e c}\right) = a_{ce}$ is the Compton radius of the electron

so that

$$32\,\pi^2 a_{co}^3 = r_o\, a_{ce}^2 \qquad \ldots(9)$$

but, for the particle, as for the electron

/3...

4. Continued...

$$\frac{r_o}{a_{co}} = \left(\frac{e^2}{m_o c^2}\right)\left(\frac{m_o c}{\hbar}\right) = \frac{e^2}{\hbar c} = \alpha \qquad \text{...(10)}$$

provided the charge e is the same as for the electron, which is true for all particles of mass greater than m_e

$$\therefore \quad 32\pi^2 a_{co}^2 = \left(\frac{r_o}{a_{co}}\right) a_{ce}^2 = \alpha\, a_{ce}^2 \qquad \text{...(11)}$$

and $\left(\frac{a_{ce}}{a_{co}}\right)^2 = \left(\frac{m_o}{m_e}\right)^2 = \frac{32\pi^2}{\alpha}$

and $\frac{m_o}{m_e} = 208\cdot 04 \qquad \text{...(12)}$

[The mass of the $\mu^{\pm}$ meson = $207 \pm 3\ m_e$]

5. When applied to the infra-plasma, the equation for the natural frequency (6) does not change because both the charge-to-mass ratio and the average charge density remain the same (e decreases but N increases proportionately). The previous analysis, therefore, holds except for the value of the Fine Structure Constant α' which is reduced as follows:

$$\alpha' = \frac{e'^2}{\hbar c} = \frac{(|P| e)^2}{\hbar c} = |P|^2 \alpha \qquad \text{...(13)}$$

so that equation 12 becomes:

$$\left(\frac{m_o}{m_e}\right)^2 \frac{1}{|P|^2} = \frac{32\pi^2}{|P|^2 \alpha} \qquad \text{...(14)}$$

but, from the new theory

$$m_e |P| = m_{ve}$$

$$\therefore \quad \left(\frac{m_o}{m_{ve}}\right)^2 = \frac{32\pi^2}{|P|^2 \alpha} \qquad \text{...(15)}$$

and it appears that $m_o = m_{\mu\pm}$ (muon ±) so that by induction

$$m_{\mu\pm} |P| = m_{\nu\mu}$$

and equation 12 is restored, having multiplied top and bottom by $|P|^2$

/4...

5. Continued...

$$\left(\frac{m_{\mu^\pm}}{m_e}\right)^2 = \left(\frac{m_{\nu_\mu}}{m_{\nu_e}}\right)^2 = \frac{32\pi^2}{\alpha} \simeq 208 \qquad \ldots(16)$$

6. The negative energy electron, therefore, appears to be associated with a negative energy plasma of $\mu^\pm$ mesons (muons). Similarly, the negative energy electron neutrino is associated with a negative energy plasma of muon neutrinos.