An Electromagnetic Force Containing Two New Terms: Derivation from a 4D-Aether

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The present author has postulated a 4-dimensional (4D) aether formed by a fluid of preons in continual motion in a 4D-space (*w,x,y,z*), where the time dimension *w* is treated exactly the same as the spatial dimensions. By specializing the equation of motion to an inviscid constant density region of 4D moving with speed *c* along the *w*-axis, we obtain Maxwell equations and the associated continuity equation. The process of derivation pinpoints physical constraints underlying MEs, and brings out the novel concept of force along the *w*-dimension. Two new terms appear in the equation for electromagnetic force, that might help explain recent experimental observations of excess energy.

Keywords: four dimensional ether; preons

1. Introduction

During the last two decades, a number of papers have documented liberation of electromagnetic (EM) energy in excess of theoretical predictions [1,2]. On the theoretical side there is a renewed interest in electromagnetism; for instance, Assis reformulation of Weber's theory [3], and Evans-Vigier longitudinal magnetic force [4]. Even within the framework of Maxwell's equations (MEs) we have found that a relaxation of the Lorentz condition† allows new solutions [5], that may lead to longitudinal magnetic components on the average [6].

There is another longstanding fundamental issue: are electric and magnetic fields **E** and **B** physical entities? O, are they merely convenient mathematical notions? We have recently revisited this question in the context of free-field solutions of MEs [7]. If one suscribes to casuality, one must conclude that charge is not a primitive notion and that fields in general—**E** and **B** in particular—are primitive concepts, having physical existence. From a realistic viewpoint, the question now becomes: what is the nature of the field?

In general relativity there is an aether [8], that in cosmological models is filled with a cosmological fluid [9]. Thomson [10] noted long ago an analogy between MEs and turbulent fluids, that was recently revived by Marmanis [11]. Furthermore, weak gravitational fields may be described by Maxwell-like equations [12,13]. It thus appears that—at least in the low mass density limit—gravitation and electromagnetism may be described as a fluid.

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† There is an ongoing controversy regarding the origin of this condition. According to M. W. Evans (private communication) it is due to Ludwig Lorenz of Denmark circa 1867, and not to Hendrik Antoon Lorentz of Holland at the turn of 20th century.

Following the leads mentioned in previous two paragraphs, we recently suggested the existence of a four-dimensional aether obeying a unified field equation (UFE) [14], as summarized in section 2. Therefrom, in section 3 the electromagnetic force is derived, which contains two new terms that might have some relation to the experimental observations showing production of energy from the vacuum. Section 4 closes this note.

2. A Four-Dimensional Hydrodynamic Aether and its Equation of Motion

Let there exist a four-dimensional (4D) space $\mathcal{R} = (w,x,y,z)$, where the time dimension $w = v_w t$ behaves exactly the same as the 3 spatial dimensions [14]. Further, let $\mathcal{R}$ be filled with a fluid of tiny particles (preons)‡ in continual motion with speed $\mathcal{V} = (v_w, v_x, v_y, v_z) = (v_w, \mathbf{v})$; each preon has mass m. No *a priori* limits on the speed v_w of preons along the w-axis are set.

(Notation: 4D-concepts and vectors are represented by handwritten (or, Greek) uppercase letters; as usual, 3D-vectors are represented either by bold face, or by an arrow on top of the symbol.)

Note that the limitations o the Special Theory of Relativity (STR) refer to the speed of particles in 3D, *i.e.* to $v = (v_x^2 + v_y^2 + v_z^2)^{1/2}$, not to the projection of the 4D-velocity $\mathcal{V}$ on the w-axis (v_w). Furthermore, our recent re-analysis of the Michelson-Morley experiment indicates that such observations are compatible with an absolute 3D-space [15]. Here, we are extending the notion of absolute space to 4D, *i.e.* to R^4. In contrast, the spacetime of STR is (ct,x,y,z), *i.e.* $R^{1,3}$.

Motion of individual preons in $\mathcal{R}$ is governed by a 4D-equation of motion, given by the matrix expression [14]

$$\partial_\mu (\rho \mathcal{V}\mathcal{V}_\alpha) = -\partial_\mu \tau_{4x4} - \partial_\mu P \tag{1}$$

where $\rho = nm$ is the preonic fluid mass density, n is the number of preons per unit 3D-volume, the column vector $\mathcal{V} = [v_w, v_x, v_y, v_z]$ is the 4D-velocity of individual preons, $\mathcal{V}_\alpha = [c, v_x, v_y, v_z]$ refers to the time-arrow, the vector operator $\partial_\mu \equiv [\partial_w, \nabla], \partial_w \equiv \partial/\partial w$ is a 4D gradient, the 4×4 matrix $\tau_{4\times4}$ is the 4D-stress tensor, and $P = P(w,x,y,z)$ is the pressure generated by the preonic fluid; the Greek index $\mu = (w,x,y,z)$. Finally, the energy-momentum tensor $\rho \mathcal{V}\mathcal{V}_\alpha$ (a 4×4 matrix) results from the dyadic product $\mathcal{V}\mathcal{V}_\alpha$.

Expanding the LHS of eq. (1) one obtains the equivalent expression

$$\begin{aligned}&(\mathcal{V}\mathcal{V}_\alpha) \cdot \partial_\mu \rho + (\rho \cdot \partial_\mu \mathcal{V}_\alpha)\mathcal{V} + \rho D_\mu \mathcal{V} \\ &= -\partial_\mu \tau_{4x4} - \partial_\mu P\end{aligned} \tag{2}$$

where the substantial derivative (or, derivative along the trajectory) is the operator $D_\mu = \mathcal{V}_\alpha \cdot \partial_\mu$. Expanding the latter we get

$$\begin{aligned}&(\mathcal{V}\mathcal{V}_\alpha) \cdot \partial_\mu \rho + \rho\{(\partial_\mu \mathcal{V}_\alpha)\mathcal{V} + \partial_\mu (\mathcal{V}^2/2) + c\partial_w \mathcal{V} + \mathcal{Z}\} \\ &= -\partial_\mu \tau_{4x4} - \partial_\mu P\end{aligned} \tag{3}$$

‡ I have borrowed the word *preon* from D. J. Larson, "The A-B-C preon model," *Physics Essays*, vol. 10, No. 1 (1997)., who uses the term preon for particles more elementary than quarks. The prefix *pre* means before in time, prior, of higher rank, thus nicely conveying our sense of *most fundamental matter*.

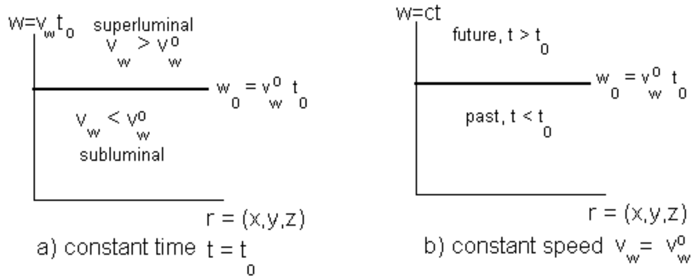

Fig. 1

Figure 1. Four-dimensional representation of universe. Different 3D-worlds may appear as the projection $w = w_0$ = constant on the w-axis. Such hypersurface divides the w–**r** diagram into two subspaces. Part a: for a given time t_0 (say the present), the hypersurface divides the diagram into: (i) preons with $v_w > v_w^0$ (above) and (ii) preons with $v_w < v_w^0$ (below). Part b: for all particles with a fixed $v_w = v_w^0$ the hypersurface divides the w–**r** diagram into: (i) the future for $t > t_0$ (above), and (ii) the past for $t < t_0$ (below). Our world corresponds to $v_w^0 = c$.

where $\mathcal{Z}$ is a 4×1 column vector related to the 3D-vorticity vector [16] $\boldsymbol{\zeta}=\nabla\times\mathbf{v}$:

$$\mathcal{Z} = \begin{pmatrix} (\vec{v}\cdot\nabla)v_w - v_w\partial_w v_w \\ \vec{\zeta}\times\mathbf{v} \end{pmatrix} \tag{4}$$

Consider now a 3D-hypersurface formed by a projection of the 4D-universe onto the w-axis, say $w = w_0 = v_w^0 t_0$ (Fig. 1). The plane w–**r** may be interpreted in two complementary ways: *Interpretation 1* (Fig. 1a). At a fixed time t_0 (say the present), the line $w = w_0$ divides the plane into three classes of particles: (i) preons moving with $v_w > v_w^0$ (above), (ii) preons moving with $v_w < v_w^0$ (below), (iii) preons moving with $v_w = v_w^0$ (on the horizontal line). *Interpretation 2* (Fig. 1b). For the class of preons moving with $v_w = v_w^0$, the line $w = w_0$ divides the plane into three periods of time: (i) The future for $t > t_0$ (above), (ii) The past for $t < t_0$ (below), (iii) The present $t = t_0$ (on the line). The conventional worldlines of STR and the space underlying Feynman diagrams belong to interpretation 2 with v_w^0 unspecified.

Finally, let us postulate [14] that we live in a 3D-hypersurface where $v_w^0 = c$, *i.e.* all preons in our world move with constant speed c. Then, our hypersurface slides with constant speed c on the w-axis from the past to the future (Interpretation 2 above). The meaning of the w-**r** plane under Interpretation 1 can now be rephrased as: at a given t_0 (say, the present) our 3D-world separates superluminal from subluminal preons. Furthermore, as seen below, there is a continuous exchange of preons between our hypersurface and the two half-spaces above and below.

For events in our hypersurface, eq. (1) becomes

$$\partial_\mu(\rho V_\alpha V_\alpha) = -\partial_\mu \tau_{4x4} - \partial_\mu P \tag{5}$$

where the individual elements $\tau_{4\times4}$ associated with the spatial dimensions is the $\tau_{3\times3}$ viscosity matrix, and the elements associated with the w-dimension are

$$\tau_{wj} = \tau_{jw} = S_j / c \ for \quad j = (x, y, z) \tag{6}$$

$$\partial_w \tau_{ww} = -\sum\nolimits_{\pm} S_w^{\pm} \delta(\mathbf{r} - \mathbf{r}_{\pm}) / c \tag{7}$$

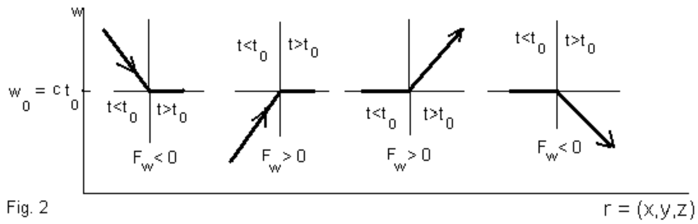

Figure 2. The four mechanisms for producing sources and sinks at a given instant of time $t = t_0$. When $F_w < 0$ there is deceleration of preons leading to a source in the first diagram and to a sink in the last one. Similarly, when $F_w > 0$ there is acceleration of preons leading to a source in the second diagram and to a sink in the third one.

where $\mathbf{S} = (S_x,S_y,S_z)$ is a (displacement) energy flux along axes *x,y,z* (dimensions: energy per unit time per unit area), and the source/sink $S_w^{\pm}$ is a concentrated energy flow along the *w*-axis (dimensions: energy per unit time), and $\mathbf{r}_{\pm}$ represents the position of the energy source/sink (positive/negative respectively), and δ(.) is a 3D-Dirac's delta function (dimensions: (lenght)$^{-3}$). Eq. (6) may be interpreted as a transfer of energy by displacement from the *w*-axis into the spatial axes (or the other way around), whereas eq. (7) is a transfer of energy along the *w*-axis. Therefore, the 4D-source $\mathbf{S} \equiv (S_w^{\pm},\mathbf{S})$ simply represents a "convective'' transfer of preons from one region of the 4D-fluid into another, *i.e.* there is conservation of energy in the whole 4D-universe .

Note that other fluid theories contain expressions similar to eq. (5) (for instance, eq. 3 in Ribaric and Sustersic[17]). However, our approach is fundamentally different because we allow for interaction between our world and other regions of $\mathcal{R}$ with $v_w \neq c$ (described by the more general eq. 1). This interaction manifests as the 4D-source $\mathcal{S}$.

The 4D-momentum and force are

$$\mathcal{P} = m\mathcal{V} = \lfloor mv_w, mv_x, mv_y, mv_z \rfloor \tag{8}$$

$$\mathcal{F} = \partial_t \mathcal{P} = \partial_t (m\mathcal{V}) \tag{9}$$

where $\partial_t \equiv \partial/\partial t$. Note that $p_w = mv_w$ reduces in our hypersurface to $p_w = mc = E/c$ which is the relativistic momentum of energy. The *force density* associated with *n* particles per unit 3D-volume is

$$\Gamma = n\mathcal{F} = \partial_t (nm\mathcal{V}) = \partial_t (\rho\mathcal{V}) \tag{10}$$

By analogy with the standard 3D-case, the 4D-preonic fluid exerts force, and performs work along the *four* dimensions (*w,x,y,z*), via its hydrodynamic pressure *P* (in this sense, *P* is interpreted as potential energy per unit volume):

$$\Gamma = -\partial_\mu P \tag{11}$$

Note that eq. (9) contains a novel concept: force along the *w*-dimension given by $F_w = \partial_t(mv_w)$. This new component of force is responsible for the appeareance of sources and sinks in our hypersurface, as follows. *Sources* of energy $\mathcal{S}$ may be generated by two mechanisms (Fig. 2a): (1) preons that move with $v_w > c$ outside our hypersurface ($w_0 = ct$) for $t < t_0$ are decelerated by $F_w < 0$, and enter our world at $t = t_0$ with $v_w = c$, (2) preons that move with $v_w < c$ outside $w_0 = ct$ for $t < t_0$, are accelerated by $F_w > 0$, and enter our world at $t = t_0$ with $v_w = c$. Likewise, *sinks* are produced by preons in our hypersurface that move with $v_w = c$ for

$t < t_0$, according to two mechanisms (Fig. 2b): (1) acceleration when $F_w > 0$, to leave our world at $t = t_0$ with $v_w > c$, and (2) deceleration when $F_w < 0$, to leave our world at $t = t_0$ with $v_w < c$.

3. The Electromagnetic Case

The preonic fluid is described by the equation of motion (1), that we interpret as a *unified field equation* (UFE) representing all forces. In the spirit of effective field theories, Maxwell equations should be a special case of UFE, valid in restricted regions of Σ where the following three conditions hold: (1) preons have $v_w = c$ (our world), (2) ρ = constant, *i.e.* $\partial_\mu \rho = 0$, and (3) the preonic flow is inviscid, *i.e.* $\tau_{3x3} = 0$ (recall section 1 [11-13]).

3.1 The Maxwellian continuity equation

The *w*-term of eq. (5), with conditions (2) and (3) above, leads to the scalar equation

$$\partial_w \rho_e + c^{-1} \nabla \cdot \mathbf{J}^{disp} = -k_e (\rho c \nabla \cdot \mathbf{v} + \partial_w P) \tag{12}$$

The displacement current density $\mathbf{J}^{\mathrm{disp}}$, electric current *I*, and electric charge density ρ_e are *auxiliary* 3D-concepts associated with 4D-energy sources $S = (S_w^{\pm}, \mathbf{S})$:

$$\mathbf{J}^{disp} = k_e \mathbf{S} \tag{13a}$$

$$I = -k_e \sum_{all\pm} S_w^{\pm} \tag{13b}$$

$$\partial_w \rho_e = -k_e c^{-1} \sum_{all\pm} S_w^{\pm} \delta(\mathbf{r} - \mathbf{r}_{\pm}) \tag{13c}$$

where k_e is a dimensional constant with the units of charge per unit energy. Hence, *I* is energy flow along the *w*-axis, and $\mathbf{J}^{\mathrm{disp}}$ is flow of energy into/from 3D from/into the *w*-axis. Electric current and charge density are related thus

$$\begin{aligned} \iiint_{V(\mathbf{r}_{\pm})} \partial_w \rho_e dV &= -\frac{k_e}{c} \iiint_{V(\mathbf{r}_{\pm})} \sum_{all\pm} S_w^{\pm} \delta(\mathbf{r} - \mathbf{r}_{\pm}) dV \\ &= -\frac{k_e}{c} \sum_{all\pm} S_w^{\pm} = \frac{I}{c} \end{aligned} \tag{14}$$

Previous definitions help explain an intriguing aspect of MEs [7], namely the difference between charge-free and charge-neutral conditions *in vacuo*. Indeed, (a) a charge-free condition attains when all $S_w^{\pm} = 0$. And, (b) a charge-neutral condition obtains when $\Sigma_{\pm} S_w^{\pm} = 0$ and at least some $S_w^{\pm} \neq 0$. The simplest case being $S_w^{+} + S_w^{-} = 0$.

It is immediately seen that eq. (12) constitutes a generalization of the continuity equation (CE) for electric charge. The Maxwellian CE obtains if the RHS is null:

$$\partial_w \rho_e + c^{-1} \nabla \cdot \mathbf{J}^{disp} = 0 \tag{15}$$

That is, the conventional CE holds if, and only if,

$$\rho c \nabla \cdot \mathbf{v} + \partial_w P = 0, \Gamma_w = -\partial_w P = \rho c \nabla \cdot \mathbf{v} \tag{16}$$

There is force density Γ_w along the w-axis when $\nabla\cdot\mathbf{v}\neq 0$, which is interpreted as a condition of compressibility of the preonic fluid. If the fluid is incompressible, then $\nabla\cdot\mathbf{v}=0$, and $\Gamma_w=0$ (automatically leading to the Maxwellian CE).

Note that the CE (15) contains a $\mathbf{J}^{\mathrm{disp}}$ that is independent of charge density ρ_e (eqs. 13a, c). This may help explain another curious feature of the CE associated with MEs [6]: it simultaneously allows $\mathbf{J}^{\mathrm{disp}}\neq 0$ and $\rho_e=0$ (this is impossible in the conventional view).

3.2 Maxwellian coupling of electric and magnetic potentials

Likewise, subsitute eqs. (13) and (16) into the 3D-spatial terms of eq. (5), and invoke conditions (2) and (3) at the beginning of section 3, to get:

$$\rho c\partial_w\mathbf{v}+\frac{\rho}{2}\nabla v^2-\rho\mathbf{v}\times(\nabla\times\mathbf{v})+\frac{\mathbf{v}}{c}\Gamma_w+\frac{1}{ck_e}\partial_w\mathbf{J}^{disp}=-\nabla P \tag{17}$$

Let **E** and **B** be the electric and magnetic fields *in vacuo*. Using a general result for any vector field [18,19], **E,B** are written as

$$\mathbf{B}=\nabla\times\mathbf{A}^B+\nabla U^B,\mathbf{E}=\nabla\times\mathbf{A}^E+\nabla U^E \tag{18}$$

where $\mathbf{A}^i$ and U^i respectively are vector and a scalar potentials associated with **E**,**B**, and $i=(B,E)$. Since fields **B** and **E** contain six components, eq. (18) introduces two artificial degrees of freedom. We have argued elsewhere [19] that the conventional form of MEs is a subset of the set of fields allowed by eq. (18) when one of the following conditions hold: (1) $U^B=$ constant, (2) $\partial_w U^B=0$, then $U^B=U(x,y,z)$, (3) $\nabla U^B=0$, then $U^B=U(t)$. Under any one of previous conditions the conventional coupling between the electric vector potential and the magnetic vector potential obtains:

$$\nabla\times\mathbf{A}^E=-\partial_w\mathbf{A}^B+\nabla U \tag{19}$$

where U is an arbitrary scalar potential.

3.3 The electromagnetic force

The conventional view is to consider EM fields and potentials as convenient mathematical constructs. In contrast, they are treated here as real physical entities associated with the motion of preons, described by the 10 independent terms of the energy/momentum matrix $\rho\mathcal{V}\mathcal{V}_a$ in the UFE (eq. 1). In that spirit, let the magnetic vector potential $\mathbf{A}^B$ be a realistic independent variable, identified with the convective transport of momentum by individual preons:

$$\mathbf{A}^B=-nmc\mathbf{v}/K_e=-\rho c\mathbf{v}/K_e \tag{20}$$

where K_e is a dimensional constant with dimensions of charge density (in CGS, esu/cm^3). Substitute eqs. (19) and (20) in (18)

$$\mathbf{B}=-\rho c\nabla\times\mathbf{v}/K_e=-\rho c\vec{\zeta}/K_e \tag{21a}$$

$$\mathbf{E}=\rho c\,\partial_{\mathrm{w}}\mathbf{v}/K_e+\nabla(U^E+U) \tag{21b}$$

Our definitions for **E** and **B** are similar to those of Hofer [20], but we start from an equation of motion for a 4D-aether, while Hofer starts from a wave equation for 3D-momentum density (his eq. 16). Our **B** is also similar to Marmanis [11], but his $\mathbf{E}=\boldsymbol{\zeta}\times\mathbf{v}$ is quite different.

Substitute eqs. (21) into (17) and recall the definition of 4D-force density (eq. 11) to get the equation of electromagnetic 3D-force density

$$\vec{\Gamma} = -\nabla P = K_e \mathbf{E} + K_e \frac{\mathbf{v}}{c} \times \mathbf{B} + \frac{\mathbf{v}}{c} \Gamma_w + \frac{1}{ck_e} \partial_w \mathbf{J}^{disp} \tag{22}$$

where the scalar electrical potential was defined as $U^E + U = \rho v^2/2K_e$. Note that the spatial components of the equation of motion (5) directly represent force density in our 3D-world. Also note that eq. (22) is independent of the explicit values of constants K_e and k_e (as expected because charge is not a fundamental concept here).

In addition to the well-known electric and Lorentz forces there are two other terms in eq. (22):

(a) A *displacement* induction force density $\mathbf{\Gamma}_{disp}$

$$\vec{\Gamma}_{disp} = \frac{1}{ck_e} \partial_w \mathbf{J}^{disp} = \frac{1}{c} \partial_w \mathbf{S} \tag{23}$$

produced by temporal variations of the displacement energy flux **S**. It exists quite independently of the existence of electric charge density ρ_e (see eqs. 13).

(b) A force density $\mathbf{\Gamma}_C$ associated with the compressibility of the preonic fluid (where eq. 20 was used):

$$\vec{\Gamma}_C = \frac{\mathbf{v}}{c} \Gamma_w = -\frac{K_e \Gamma_w}{\rho c^2} \mathbf{A}^B \tag{24}$$

Three cases appear: (a) Expansion of flow, $\nabla\cdot\mathbf{v} > 0$, then $\Gamma_w > 0$. Preons are accelerated along the w-axis: either out of our hypersurface to the region above, or into our world from below (see Fig. 2). Since there is expansion, the net effect is a loss of preons (*i.e.* loss of energy) from our hypersurface. Here, $\mathbf{\Gamma}_C$ is antiparallel to the magnetic potential $\mathbf{A}^B$. (b) Compression of flow, $\nabla\cdot\mathbf{v} < 0$, then $\Gamma_w < 0$. Preons are decelerated along the w-axis: either into our world from above, or out of our world to the region below it (Fig. 2). Since there is compression, the net effect is a gain of preons (*i.e.* gain of energy) in our hypersurface. Here, $\mathbf{\Gamma}_C$ is parallel to the magnetic potential $\mathbf{A}^B$. (c) Incompressible flow, $\nabla\cdot\mathbf{v} = 0$, then $\Gamma_w = 0$ and $\mathbf{\Gamma}_C = 0$. Recalling that the derivation of MEs was made for constant ρ, then, if compressibility/expansion implies changes in ρ, it follows that, strictly speaking, MEs only hold in case (c). Of course, the equation of motion (5) is still applicable, but it does not reduce to MEs.

4. Concluding Remarks

There are many implications of the model proposed herein, some of them are experimentally testable. On the theoretical side, we mention that charge does not appear in the UFE (1), that only contains energy and momentum of preons. The concept of electric charge (eqs. 13b,c) is associated with $S_w^{\pm}$; specifically, the sign of charge is the sign of source/sink. By extension, particles are associated with the existence of energy sources and sinks in our hypersurface.

The displacement current density vector $\mathbf{J}^{disp}$ appears in the continuity equation (CE), it is independent of charge density ρ_e. The scalar conduction current density J^{cond} is associated with sources/sinks, as follows: apply the Gauss-Ostrogadskii theorem to a surface $\mathbf{A}(\mathbf{r}_{\pm})$ surrounding the sources at $\mathbf{r}_{\pm}$ (eq. 14). Assuming that the sources $S_w^{\pm}$ are isotropic and that propagation occurs in a non-absorbing isotropic medium (say empty space), then

$$I = \iiint_{\mathbf{A}} J^{cond}\, \frac{\mathbf{r}}{r} \cdot d\mathbf{A} = \pm 4\pi r^2 J^{cond} \tag{25}$$

or, in terms of energy and pressure

$$\frac{\sum_{\pm} S_w^{\pm}}{c} = \iiint_{\mathbf{A}} P^{cond}\, \frac{\mathbf{r}}{r} \cdot d\mathbf{A} = \pm 4\pi r^2 P^{cond} \tag{26}$$

Purcell [21, pages 23-24] makes an analogy between a source that emits particles in all directions at a steady rate, and the electric field strength E. Eq. (26) provides the equivalent connection between the source intensity and the component of pressure directly associated with the source. Eq. (25) is simply proportional to (26).

By the way, eq. (26) immediately leads to an alternative formulation of both *Newton's* and *Coulomb's inverse-square laws*. Through pressure P^{cond}, the preonic flow is either repulsive (source), or attractive (sink):

$$\vec{\Gamma}_{cond} = -\nabla P^{cond} = \frac{\nabla(\sum_{\pm} S_w^{\pm})}{4\pi c r^2} \tag{27}$$

Turning to the 3D-electromagnetic force (eq. 22). It also contains several surprises: (a) It is completely independent of the concept of charge (*i.e.*, independent of K_e and k_e). (b) It contains an inductive force density by displacement $\mathbf{\Gamma}_{disp}$. (c) It contains a force density due to compressibility of the preonic fluid $\mathbf{\Gamma}_C$. The last term is parallel/antiparallel to the magnetic potential and *might* be related to the Evans-Vigier force [4]. When $\mathbf{\Gamma}_C \neq 0$, compression/expansion of preonic fluid may imply that mass density ρ may not be constant, thus requiring an extension of MEs.

The practical importance of the two new force terms $\mathbf{\Gamma}_{disp}$ and $\mathbf{\Gamma}_C$ in eq. (22) is that they represent transfer of energy from the fourth dimension w into our 3D world. Hence, they may help explain some recent experimental observations [1,2].

Finally, let us recall that we imposed the coupling eq. (19) to get MEs from eq. (5), this condition plays the role of a (Lorentz) gauge. Let us relax it. Then, other solutions of eq. (18) are possible, for instance with $U^B = U^B(w,x,y,z) \neq$ constant. This may lead to additional terms in the electromagnetic force, related to a magnetic source condition $\nabla\cdot\mathbf{B} = \nabla^2 U^B(w,\mathbf{r}) \neq 0$ [5].

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