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Microscopic Processes in Electrodynamic Phenomena

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Abstract

The consequences of the hypothesis that the charges flowing in a wire and constituting the electric current drag the aether that exists outside and permeates the inside of the wire have been examined with the methods of mathematical physics. The satisfactory confirmation of Ampere's law shows that the origin of the force of interaction between current-carrying conductors, and of the magnetic force in general, is to be ascribed to the state of motion of the aether and to the variation of the static and dynamic pressures that this motion generates. The validity of the principles of this theory is also demonstrated by calculations that reveal new terms contributing to the force between current-carrying conductors. These supplementary terms correspond to the behavior of matter in a magnetic field and are missing in the original works of Ampere. This raises questions about the extent to which Ampere's law was actually derived from experiments at the time of its enunciation. The results obtained herein find appropriate the substitution of the notion of magnetic field with that of aether field. Formulated conversely, the present theory shows how Ampere's effect can be considered a confirmation of the fact that vacuum is filled with aether in a state of static pressure, the magnetic effects arising from aether movement brought about, among others, by the movement of electric charges.

Keywords: electrodynamics, fluid mechanics, Bernoulli equation, Ampere's law

Introduction

A work published recently [1] discussed the mechanism by which the magnetic lines of force are rendered visible by fine iron filings and showed how the electrodynamic effects can be explained by considering the aether in a state of motion. The necessity of employing the aether in the theory outlined therein came from the fact that, unlike other known physical phenomena, those pertaining to electrodynamics occur even in spaces from which all the known matter (solid, liquid and gaseous) has been removed, i.e. in the Torricellian vacuum. The aether is identified as the substance that remains in the vacuumed space of a mercury barometer or fills the interstellar space and its existence is proved beyond doubt by a number of effects in which it plays key roles: ideal fluid that acts as a transmitting medium in the propagation of light, ideal fluid obeying the laws of fluid dynamics as observed in the attraction and repulsion between current-carrying conductors, ideal fluid susceptible to radiation pressure and obeying the laws of fluid statics as seen in gravitation [2].

The qualitative observations made in [1], while helpful for understanding the intricacies of the phenomena under consideration, need however to be supplemented by quantitative evaluations. These are treated in the present work, where the hypothesis of aether drag by moving charges is used to obtain experimentally observable quantities and the mathematical equations that they obey, making possible their comparison with those employed by the present science. It will be seen that there is a striking agreement between the former and the latter, which necessarily implies that the hypothesis under discussion is tenable and constitutes the physical principle underlying all electrodynamic phenomena.

The Electric Current

In a simple chemical cell of the type $Zn|H_2SO_4|Cu$ it is experimentally observed that the zinc electrode is continually dissolved, while at the copper electrode hydrogen gas is accumulated.

Dissolvation implies that the Zn-Zn chemical bonds of the metallic zinc electrode are broken, this process beginning with the zinc atoms situated at the surface of the electrode and in contact with the acid. There are no reasons to believe that the fracture of Zn-Zn bonds is symmetrical between the atom leaving the electrode and those remaining in the bulk. On the contrary, the latter seems to retain a bigger fragment of the broken bond since the flow of the resulting electric current along the wire of the external circuit is from the zinc electrode towards the copper electrode. This flow can thus be conceived as being composed of the fragments of broken chemical bonds that accumulate at the zinc electrode due to its dissolvation.

The fact that electrode dissolvation occurs atom by atom results in the fragments of broken chemical bonds being in their turn quantized. In today's parlance these units are called electrons. However, as science has not yet specified the nature of electric charge in general and that of the electron in particular, it is appropriate at the present stage of understanding to always remember that they are in fact fragments of broken chemical bonds. This is why, excepting the few cases where there is need for consistency with the actual terminology and will be called electrons, the constituents of the current that is born in the outer circuit of a chemical cell will be called fragments of chemical bonds.

The process of dissolvation by which the atoms of zinc leave the electrode and pass into the acid solution continually exposes fresh electrode surface to the action of the acid. It is possible to assume that, at every atomic site of the electrode, dissolvation is a periodic process in which a zinc atom at the surface enters the sphere of influence of a molecule of acid that removes it from the bulk, followed by a new molecule of acid taking position at the freshly uncovered zinc atom and repeating the same process. Since for every atom of zinc removed from the electrode a fragment of broken bond will be released into the outer circuit and contribute to the electric current, the frequency of what is commonly called a continuous current can be estimated based on the periodicity with which zinc atoms dissolve in the acid solution. Such estimation can be obtained from the available experimental data derived from the electrolysis of zinc, knowing that the process of electrolysis and that of chemical decomposition are one the reverse of the other. Taking the electro-chemical equivalent of divalent zinc

$$Z_{Zn} = 3.39 \cdot 10^{-4}$$

which is the mass in grams of substance transported by unit current in unit time in electrolysis, and the atomic weight of zinc

$$A_{Zn} = 65.41$$

which is the mass in grams of a system containing $N_A = 6.02 \cdot 10^{23}$ atoms of zinc, the frequency with which zinc atoms dissolve in a cell that generates a unit current of 1A is found as:

$$\left(Z_{Zn} / A_{Zn}\right) \cdot N_A = 3.12 \cdot 10^{18} \text{ atoms/s}$$

This shows that the current generated by a chemical cell indeed does not have an infinite frequency (zero period) but a finite one of magnitude

$$f = 3.12 \cdot 10^{18} \text{ Hz} \qquad \text{Eqn.1}$$

It should be noted that eqn.1 gives the lower limit for the frequency and corresponds to the situation in which the atoms at the surface of the electrode dissolve all at once, followed by those immediately beneath the surface, and so on. In reality, the dissolvation process does not occur with such a degree of regularity and, in the period between the dissolvation of two zinc atoms situated at two neighboring points of the electrode, zinc atoms may dissolve at other locations of the surface of the electrode. This has the effect of increasing even more the frequency of the electric current that results.

These observations, although referred only to the very first voltaic cell discovered [3], do not apply solely for this case and are of general validity. They recognize that the electric current is in reality made of particulate units that succeed each other in their movement along the circuit at very high frequencies of the order of 10^9 GHz and, in the same time, that this particulate structure of the electric current does not mean its uniform character should be reconsidered. This is why the electric current can still be expressed as a physical quantity encountered universally in any process where flow occurs. Its strength, or intensity i, is the number N of fragments that pass in unit time through the cross-section of a conductor

$$i = \frac{dN}{dt} \qquad \text{Eqn.2}$$

If n denotes the density of flowing fragments per unit length of wire

$$n = \frac{dN}{dx} \qquad \text{Eqn.3}$$

then eqn.2 can be written as

$$i = \frac{dN}{dx} \cdot \frac{dx}{dt} = n \cdot u \qquad \text{Eqn.4}$$

where u is the speed of the fragments moving along the conducting wire.

Transient Phenomena in a Rectilinear Conductor

It is well known that a tension develops at each electrode of a chemical cell even in the situation when the respective electrodes are not united by a conducting wire. The presence of such a tension is a definite sign of an incipient chemical action, which can be ascertained with the help of an electroscope. [4] When the two electrodes of the cell are connected with a conducting wire the chemical forces developed between the electrodes and the acid generate an aether pressure gradient along the wire that sets into motion the charges (fragments of chemical bonds) freed during the process of dissolvation. The force exerted on the fragments due to aether pressure gradient is Archimedic in nature, given by:

$$F = -\nabla p \cdot d \cdot V \qquad \text{Eqn.5}$$

where V is the volume and d is the absolute density of an individual fragment. [2]

In the absence of other disturbing factors, this force causes the acceleration of the fragments along the wire according with Newton's second law of motion [2]:

$$-\nabla p \cdot d \cdot V - m_i \cdot a = 0 \qquad \text{Eqn.6}$$

where m_i can be expressed as:

$$m_i = f(u) \cdot d \cdot V \qquad \text{Eqn.7}$$

Eqn.6 becomes:

$$-\nabla p - f(u) \cdot a = 0 \qquad \text{Eqn.8}$$

In contrast with this simple situation, the fragments of broken chemical bonds freed in the outer circuit by dissolvation of zinc electrode actually move along the connecting wire through an aether that is not free but partially bound to the substance of the wire, as ascertained by the conclusive experiments of Fizeau. Consequently, the moving fragments encounter from the aether a force of resistance proportional with their instantaneous speed u given by Stokes formula [5]:

$$D = \gamma \cdot u \qquad \text{Eqn.9}$$

This force of resistance, while due exclusively to the interaction between the flowing charges and the aether, is not a function only of the properties of the aether, because the aether is set into motion along both of the sides, exterior and interior, of the conducting wire. This makes γ dependent on the easiness with which the aether flows in the interior of the wire, which in its turn determines the instantaneous speed of the flowing charge. Due to this dependency, γ in fact reflects the way the substance of the wire impedes the flow of the fragments of broken chemical bonds along its surface and thus represents the defining parameter of the resistivity of the wire.

With the force of resistance of eqn.9, the equation of motion valid at any time for the fragments of chemical bonds traveling along the rectilinear wire changes from eqn.8 into:

$$-\nabla p - f(u) \cdot a - \frac{\gamma}{d \cdot V} \cdot u = 0 \qquad \text{Eqn.10}$$

or,

$$f(u) \cdot \frac{du}{dt} + \frac{\gamma}{d \cdot V} \cdot u + \nabla p = 0 \qquad \text{Eqn.11}$$

This equation can be further simplified if the movement of fragments along the conducting wire and through the aether is considered to occur without aether turbulence. This would correspond to low current intensities, when $f(u)$ is a constant

$$f(u) = \lambda$$

Further, if the fragments are supposed to have no internal structure, then

$$d = 1$$

In these conditions, eqn.11 becomes

$$\lambda \cdot \frac{du}{dt} + \frac{\gamma}{V} \cdot u + \nabla p = 0 \qquad \text{Eqn.12}$$

whose integration gives the solution:

$$u = \frac{-\nabla p \cdot V}{\gamma} \cdot \left(1 - e^{-\frac{\gamma}{\lambda \cdot V} \cdot t}\right) \qquad \text{Eqn.13}$$

a result that shows a remarkable identity between the time dependence of the velocity of the fragments of broken chemical bonds moving along the conducting wire and the time dependence of the instantaneous electric current observed in a simple resistance-inductance (RL) circuit during the transient period. [6]

This agreement is significant and offers an important support for the hypothesis that the charges that constitute the electric current flowing in a conductor move through the aether with friction, which in turn causes the latter to be set in motion by the former. The gradual increase in the intensity of the current in a wire during the transient period can thus be ascribed to the gradual increase in the speed of the fragments of chemical bonds flowing along the conducting wire, the stationary current corresponding to the situation in which the moving fragments reach the limit velocity. Of course, since eqn.4 states that the electric current is proportional both with the speed and the linear density of the fragments flowing in the circuit, it can be argued that it is not the speed but the number of fragments freed into the outer circuit at the zinc electrode that increases in time once the circuit is closed and the chemical changes are initiated in the cell. This would imply that the speed at which zinc electrode dissolves follows the time dependence of eqn.6, a possibility that seems untenable for there is no experimental evidence that supports this view.

In this section it was shown how the principle of aether drag by the electric charges moving in a current-carrying conductor is confirmed experimentally through the identity between the time dependence of the electric current intensity during the transient period and that of the velocity of the fragments of broken chemical bonds during their accelerated motion along the wire. In the next sections the same principle will be examined for the case of stationary state.

Laminar Flow in Aether. Aether Velocity Field in the Vicinity of a Current-Carrying Conductor

It was shown in the foregoing discussions, and it is actually a well-known fact, that an electric current consists of units that flow along the conductor at a certain speed and follow each other at extremely short intervals of time. As discussed in [1], there are strong reasons to believe that the flowing charges -fragments of broken chemical bonds- which constitute the electric current behave as solids moving through the aether and guided by the conducting wire. The effect of their flow is to entrain the aether in a movement along the current-carrying conductor.

In order to obtain the dependence of aether velocity with the distance r from the axis of a rectilinear current-carrying wire, some assumptions need to be made concerning the way in which the flowing charges actually set in motion the aether they are flowing through and the way this motion is transmitted at distances away from the axis of the wire. It was seen how the hypothesis that the flow of charges along the wire occurs with friction is tenable as it yields the time dependence for the velocity of the flowing electric charges identical with the actual behavior observed experimentally for the electric current during the transient period. The fact that the electric charges move through the aether with friction does not necessarily mean that the aether itself is a viscous fluid. As it can be quite easily proven by experiments in the Torricellian vacuum, the difference between the drag on a charged solid in motion and that on a neutral one is extremely low, if detectable at all. This shows that the aether can hardly be conceived as having any internal shear forces and points to the conclusion that the motion of the aether at a distance r from the axis of a current-carrying wire is not due to propagation by aether shear forces of the motion originated at the wire, but it is simply due to the fact that the charges generate wakes in their motion through the aether.

This approach is not only the simplest but is also the only one that makes unnecessary the introduction of a property that the aether is not probable to possess: viscosity. It has been, for this reason, adopted in the present work, where it is assumed that the electric charges passing through the conductor cross-section at a certain moment displace the aether existing in their path and send a fraction of it away from the wire in the form of a wake that makes a fixed angle α with the direction of the conductor. (Fig.1) Again, the fact that the movement of the electric charges through the aether occurs with friction is an important element, since it is due to this reason that a boundary layer is formed between the charges and the aether which eventually results in the formation of the wake, being known that in the case of an ideal frictionless flow of solid bodies through fluids no wakes are generated. The angle α depends on the particular details of the geometry of the boundary layer leading to the generation of the wake and its specific value will not be discussed here for it has no significant bearing on the final result. The flow of electric charges along a rectilinear conductor can thus be represented as a line-source in which every electron that drags the aether represents a moving source of outgoing aether. [7] This view, it appears, is very similar to that which has been supported by John Henry Poynting. [8]

Thus, after the transient period has passed and a stationary state for the flow of the electric current has been attained in the wire, we can speak also of a stationary aether velocity field that surrounds the respective current-carrying wire.

The speed q of the aether wake at the moment of its generation by a moving charge has the component along the direction of the wire

$$q_0 = u_0 \cdot \cos\alpha \qquad \text{Eqn.14}$$

where u_0 is the speed of the charge moving along the wire. The component of q in a direction perpendicular to the wire is

$$w_0 = u_0 \cdot \sin\alpha \qquad \text{Eqn.15}$$

The dependency of q with the distance from the wire will be found from considerations related to the flow of aether at some distance away from the source of the wake, where the flow obeys the equations of motion for an ideal frictionless fluid in a state of laminar flow. The first of these equations is the equation of continuity for the incompressible fluid [9]:

$$\frac{\partial q_x}{\partial x} + \frac{\partial q_y}{\partial y} + \frac{\partial q_z}{\partial z} = 0 \qquad \text{Eqn.16}$$

Laminar flow implies that the relative motion of the parts of the fluid consists only of pure displacements. This is equivalent with the condition of non-turbulent, or irrotational, flow, i.e. of flow that does not occur around any instantaneous system of rectangular axes. It can be shown that such a condition is met if a velocity-potential function φ exists that satisfies the relations

$$q_x = -\frac{\partial \varphi}{\partial x} \qquad q_y = -\frac{\partial \varphi}{\partial y} \qquad q_z = -\frac{\partial \varphi}{\partial z} \qquad \text{Eqn.17}$$

The equation of continuity for the compressible fluid (eqn.16) can be written in terms of the velocity-potential function as

$$\frac{\partial^2 \varphi}{\partial x^2} + \frac{\partial^2 \varphi}{\partial y^2} + \frac{\partial^2 \varphi}{\partial z^2} = 0 \qquad \text{Eqn.18}$$

Since the flow is identical for every point along the length of the wire and is also symmetric around the axis represented by the wire, it will be more convenient to express both eqn.18 and its solution in polar coordinates. Taking the z-axis along the rectilinear wire in the direction of the moving charges, eqn.18 becomes:

$$\frac{1}{r}\cdot\frac{\partial}{\partial r}\left(r\cdot\frac{\partial\varphi}{\partial r}\right)+\frac{1}{r^2}\cdot\frac{\partial^2\varphi}{\partial\theta^2}+\frac{\partial^2\varphi}{\partial z^2}=0 \qquad \text{Eqn.19}$$

The symmetry around the axis of the wire implies that the solution will be a function independent of the polar angle θ, of the form:

$$\varphi(r,\theta,z)=\varphi(r,z)$$

With this provision, eqn.19 transforms into

$$\frac{1}{r}\cdot\frac{\partial}{\partial r}\left(r\cdot\frac{\partial\varphi}{\partial r}\right)+\frac{\partial^2\varphi}{\partial z^2}=0 \qquad \text{Eqn.20}$$

One of the possible solutions of eqn.20 is obtained when both terms are equal with a constant, so that:

$$\frac{1}{r}\cdot\frac{\partial}{\partial r}\left(r\cdot\frac{\partial\varphi}{\partial r}\right)=C \qquad \text{Eqn.21}$$

and

$$\frac{\partial^2\varphi}{\partial z^2}=-C \qquad \text{Eqn.22}$$

Integration of eqn.21 with respect to r yields

$$\frac{\partial\varphi}{\partial r}=C\cdot\frac{r}{2}+\frac{D}{r} \qquad \text{Eqn.23}$$

The condition that the radial speed $q_r=\partial\varphi/\partial r$ be zero at infinity yields the value zero for the constant C. The speed becomes simply

$$q_r=\frac{D}{r} \qquad \text{Eqn.24}$$

and the solution to eqn.23 is

$$\varphi=D\cdot\log r \qquad \text{Eqn.25}$$

With constant C equal to zero, the solution of eqn.22 is

$$\frac{\partial\varphi}{\partial z}=f(r)\cdot E \qquad \text{Eqn.26}$$

which is also the aether speed along the current-carrying conductor

$$q_z=\frac{\partial\varphi}{\partial z}=f(r)\cdot E \qquad \text{Eqn.27}$$

where the form of function $f(r)$ is to be determined from other conditions of the flow. The aether speed in the radial direction is

$$q_r=\frac{D}{r}=q\cdot\sin\alpha \qquad \text{Eqn.28}$$

from which q is obtained as:

$$q = \frac{D/\sin\alpha}{r} \qquad \text{Eqn.29}$$

The aether speed q_z in the z-direction, parallel to the conductor, is obtained as:

$$q_z = q \cdot \cos\alpha = \frac{D/tg\alpha}{r} \qquad \text{Eqn.30}$$

The constant D can now be determined from the condition of aether flow at the surface of the conductor. Supposing the radius of the conductor equal to r_0, eqn.30 together with eqn.14 yield:

$$q_z\big|_{r=r_0} = \frac{D/tg\alpha}{r_0} = u_0 \cdot \cos\alpha$$

The constant D is obtained as:

$$D = u_0 \cdot r_0 \cdot \sin\alpha$$

and eqn.30 becomes

$$q_z = \frac{u_0 \cdot r_0 \cdot \cos\alpha}{r} \qquad \text{Eqn.31}$$

If the value $\cos\alpha$ will be called, for brevity, K, so that

$$\cos\alpha = K$$

the aether speed in a direction parallel with the wire will be

$$q_z = \frac{u_0 \cdot r_0 \cdot K}{r} \qquad \text{Eqn.32}$$

The above discussion referred only to the situation in which a single electric charge moving along a wire transfers motion to the aether as a wake. To find the speed imparted to the aether by a current constituted of a number of n such charges per unit length, it is necessary to obtain the average speed imparted to the aether along an arbitrary length Δx of the wire. This speed is given by:

$$q = n \cdot \frac{\delta}{\Delta x} \cdot \frac{u_0 \cdot r_0}{r} \qquad \text{Eqn.33}$$

where δ is the specific length of the fragments along the direction of their movement and Δx is an arbitrary length of the wire so that:

$$\Delta x >> \delta$$

It can be seen that the condition of

$$n \cdot \frac{\delta}{\Delta x} < 1$$

has the physical significance that the speed imparted to the aether per unit length of wire is actually only a fraction of speed of the individual charges moving along the respective length Δx.

The component of aether velocity along the direction of the moving charges is obtained as

$$q_z = n \cdot \frac{\delta}{\Delta x} \cdot \frac{u_0 \cdot r_0 \cdot K}{r}$$

that can be written

$$q_z = \frac{I_0 \cdot r_0}{r} \cdot \Lambda \qquad \text{Eqn.34}$$

where $I_0 = n \cdot u_0$ is the intensity of the current flowing in the wire (eqn.4) and

$$\Lambda = \frac{\delta \cdot K}{\Delta x}$$

is a constant.

The above results show that the velocity q of the aether decreases as the inverse of the distance from the wire (eqn.33), which is consistent with the equations found in [10]. From eqn.34 it can be seen that the component q_z of the aether velocity parallel with the direction of the flowing charges has the same kind of dependence with $1/r$.

Bernoulli Equation for the Aether

In the mechanics of deformable bodies the Bernoulli equation is a direct result of the application of Newton's second law of motion to the case of continuous media [11]. Newton's second law of motion has, however, some difficulties coming from the fact that it employs the notion of mass. These difficulties have been addressed in [2] where it was demonstrated that mass is not a property of matter but a dynamical effect generated by the acceleration of a macroscopic body through the aether. In the same work the so-called gravitational mass derived from the force of weight was shown to have a similar underlying origin, being due to sheer buoyancy in the aether. The intrinsic value of Newton's second law of motion as a fundamental principle of physics has been preserved nevertheless, in that it was shown that the force F_{action} acting on a body immersed in aether and the resulting acceleration $a_{reaction}$ with which the body reacts to it are indeed proportional, so that

$$F_{action} - m_i \cdot a_{reaction} = 0 \qquad \text{Eqn.35}$$

The constant of proportionality, m_i, was called constant of inertia. [2]

Inertia effect was shown to arise from the aether pressure gradient that is generated around a body in its movement at changing speed through the aether. This aether pressure gradient leads to an Archimedic-like force F_{ae} acting in a direction opposed to the force F_{action} that causes the movement, and therefore opposing the movement of the body. Mathematically, this force was expressed as:

$$F_{ae} = -\nabla p \cdot d \cdot V \qquad \text{Eqn.36}$$

where V was the volume of the macroscopic body and d the absolute density of its matter, a dimensionless quantity giving the fraction of the volume of a macroscopic body that is occupied by the constituent atoms.

The sum of the action and the reaction forces acting on a body is zero, so that

$$F_{action} + F_{ae} = 0 \qquad \text{Eqn.37}$$

Using eqn.35 and eqn.36, this can be expressed as:

$$m_i \cdot a_{reaction} - \nabla p \cdot d \cdot V = 0 \qquad \text{Eqn.38}$$

The constant of inertia effect m_i can be obtained from above as

$$m_i = \frac{\nabla p}{a} \cdot d \cdot V$$

and, from the behavior of bodies moving through fluids, can be of the general form:

$$m_i = f(u) \cdot d \cdot V$$

where u is the speed of the moving macroscopic body with respect to the aether.

The results discussed above have been reminded because they are needed in finding the laws of motion and implicitly the Bernoulli equation for the aether. It can be seen that for this particular case the absolute density is

$$d = 1$$

for the obvious reason that by definition the aether completely fills any arbitrarily chosen volume of free space. The constant of inertia for aether becomes:

$$m_i = f(u) \cdot V$$

The equation of motion of a volume V of aether can be found by considering an action force F_{action} that can be expressed as a pressure gradient:

$$F_{action} = -\nabla p \cdot V$$

Newton's second law of motion for the aether can then be written as

$$f(u) \cdot V \cdot a - \nabla p \cdot V = 0 \qquad \text{Eqn.39}$$

The total acceleration is given by:

$$a = \frac{\partial u}{\partial t} + u \cdot \nabla u$$

and becomes

$$a = u \cdot \nabla u$$

for stationary conditions where $\partial u / \partial t = 0$.

Eqn.39 can then be written as:

$$-\nabla p - f(u)\cdot u\cdot\nabla u = 0$$

and can be integrated to the simple form

$$p + f(u)\cdot\frac{u^2}{2} = E \qquad \text{Eqn.40}$$

provided that the function $f(u)$ satisfies the condition:

$$\nabla f = 0 \qquad \text{Eqn.41}$$

Equation 40 is then the Bernoulli equation for the aether and signifies that, along a line of flow on which there are not accelerations ($\partial u/\partial t = 0$), the total sum between the static pressure p and dynamic pressure $f(u)\cdot u^2/2$ is a constant (E). This important result was obtained for the first time in 1738 by Daniel Bernoulli and published in his work on hydrodynamics. [12]

A particularly notable consequence of this equation is that a spatial variation of the speed along a flow line results in a variation of the static pressure and, as the static pressure acts on any direction in a fluid, this leads to the generation of forces acting on bodies in all possible directions within the fluid, even in a direction perpendicular to the flow line.

The simplest analytical function that satisfies eqn.41 is obtained when the solution is a constant independent of the speed u

$$f(u) = \sigma$$

which will be taken, for simplicity

$$\sigma = f(u) = 1$$

Then the Bernoulli equation for the aether becomes

$$p + \frac{u^2}{2} = E \qquad \text{Eqn.42}$$

which is dimensionally correct based on the arguments presented in [2], where the quantity of matter Q_m contained in a body was shown to have dimension of m^3 and the mass to be a dynamical effect due to Archimedic forces that exist in static and moving aether. It is worth to note that eqn.42 does not contain the density of the aether, which is physically meaningful since the notion of mass cannot be defined for the case of the aether proper, but only for macroscopic bodies that accelerate through the aether. [2] The Bernoulli equation in this form will be used in what follows for the case of two parallel, current-carrying conductors.

Two Parallel Current-Carrying Conductors. Verification of Ampere's Law

In this section two parallel conductors of square cross-section $2 \cdot b$ and situated at a distance d apart will be considered carrying electric currents of intensities I_1 and I_2. From eqn.34 it follows that, in the absence of the current-carrying wire 2, the aether velocity generated by current I_1 in a direction along the wire 1 can be written as:

$$q_1(r) = \frac{I_1 \cdot b}{r} \cdot \Lambda_1 \qquad \text{Eqn.43}$$

Placing the second current-carrying wire 2 at a distance d from wire 1 and parallel to it (fig.2) causes the aether speed around wire 1 to differ at its opposing faces A and B. At face A the aether speed will be the vector sum of the aether speed generated by the charges moving in 1 and that generated at surface A of wire 1 by the charges moving in wire 2, so that

$$q_{1A} = q_1(b) \pm q_2(d) = I_1 \cdot \Lambda_1 \pm \frac{I_2 \cdot b}{d} \cdot \Lambda_2 \qquad \text{Eqn.44}$$

where the plus sign refers to the situation when the two currents flow in the same direction and minus sign to that in which they flow in contrary directions.

The substance and the current of wire 1 will diminish the aether speed generated by the current of wire 2 at the surface B of wire 1. For simplicity, in the present calculations will be considered the ideal situation in which the screening off in total (see in fig.2 the missing surface Σ in the wake of wire 2). The aether velocity field at surface B along the whole length of the wire 1 will be then only that originated by the charges that drag the aether in wire 1 and given by:

$$q_{1B} = q_1(b) = I_1 \cdot \Lambda_1 \qquad \text{Eqn.45}$$

The situation of the aether speed at the faces C of wire 1 is symmetric, the aether speed is identical along the two opposing C surfaces and no static pressure difference will exist between them.

Applying Bernoulli equation to the aether flow surrounding the wire 1, the difference Δp_1 between the static aether pressures acting on the opposing faces B and A is obtained from eqn.42 as:

$$\Delta p_1 = p_{1B} - p_{1A} = \frac{1}{2} \cdot \left(q_{1A}^2 - q_{1B}^2\right) \qquad \text{Eqn.46}$$

which is positive in the direction from wire 1 to wire 2. It should be noted that, although the faces A and B of wire 1 do not belong to the same aether flow line, the Bernoulli equation (eqn.42) is applicable nevertheless, since for a fluid of infinite extension all the flow lines originate in the fluid at rest at infinity and therefore all have the total pressure equal to the same constant E.

Using the expressions for q_{1A} (eqn.44) and for q_{1B} (eqn.45), the difference of static pressure Δp_1 on wire 1 becomes:

$$\Delta p_1 = \frac{1}{2}\cdot\left[\pm\frac{2\cdot I_1\cdot\Lambda_1\cdot I_2\cdot b\cdot\Lambda_2}{d}+\left(\frac{I_2\cdot b}{d}\cdot\Lambda_2\right)^2\right] \qquad \text{Eqn.47}$$

This difference of static pressures corresponds to a force F_{12} between the two conductors 1 and 2 of magnitude

$$F_{12} = \Delta p_1\cdot A = \Delta p_1\cdot b\cdot L$$

where A is an arbitrary surface corresponding to an arbitrarily chosen length L along the wire 1.

The force f_{12} per unit length L of wire 1 will be:

$$f_{12} = \frac{F_{12}}{L} = \Delta p_1\cdot b$$

Using eqn.47 for the expression of Δp_1, the force f_{12} becomes

$$f_{12} = \pm\frac{I_1\cdot I_2}{d}\cdot\Lambda_1\cdot b^2\cdot\Lambda_2+\frac{I_2^2}{2\cdot d^2}\cdot b^3\cdot\Lambda_2^2 \qquad \text{Eqn.48}$$

which it can be seen that becomes identical with the expression for the force given by Ampere's law [13] provided that the second term of higher order is neglected.

It is important to observe that the supplementary term found in the present calculations is independent of the properties of wire 1 or of the current I_1 flowing through it and seems to correspond to the physical situation in which a macroscopic body (wire 1) is attracted to current-carrying wire 2 simply due to the presence of the former in the dynamic aether field (magnetic field) generated by the latter. This can be related to the known behavior of paramagnetic and ferromagnetic substances, while the cause for which the constants of material of wire 1 do not enter in the equation for the force can be traced to having considered in the above calculations the ideal case in which the effect of the aether flow generated by wire 2 at the surface B of wire 1 is zero, being completely screened off by the latter. If, however, the screening off is taken to be partial and the degree of screening to be related to the constants of material of the wire 1, eqn.45 for the aether speed at surface B of wire 1 becomes

$$q_{1B} = q_1(b)\pm\chi_1\cdot q_2(d) = I_1\cdot\Lambda_1\pm\chi_1\cdot\frac{I_2\cdot b}{d}\cdot\Lambda_2 \qquad \text{Eqn.53}$$

where χ_1 is a fraction of the aether speed generated by the current flowing in wire 2 at face A of wire 1. It can be seen by application of Bernoulli equation that considering this more physically possible situation will make the supplementary term in the expression of the interacting force dependent on the properties of the material of wire 1, properties being cumulated here in the parameter χ_1. The existence of these supplementary terms is significant in that it reveals that the original law of Ampere actually does not take into consideration at all the particular constants (magnetic properties) of the substances that constitute the current-carrying wires, making thus questionable if this law was in fact confirmed completely by experiments.

It may be of interest to remark that James Clerk Maxwell was also in doubt that Ampere discovered his law based on experiments. Referring to Ampere's law in its differential form (that gives the interaction force between two elements of current), James Clerk Maxwell made the following pertinent observations:

"No experiments on the mutual action of unclosed currents have been made. Hence no statement about the mutual action of two elements of circuits can be said to rest on purely experimental grounds. It is true we may render a portion of a circuit moveable, so as to ascertain the action of the other currents upon it, but these currents, together with that in the moveable portion, necessarily form closed circuits, so that the ultimate result of the experiment is the action of one or more closed currents upon the whole or a part of a closed current." [14]

"The method of Ampere, however, though cast into an inductive form, does not allow us to trace the formation of the ideas which guided it. We can scarcely believe that Ampere really discovered the law of action by means of the experiments which he describes. We are led to suspect, what, indeed, he tells us himself, that he discovered the law by some process which he has not shewn us, and that when he had afterwards built up a perfect demonstration he removed all traces of the scaffolding by which he had raised it." [15]

Finally, it may be helpful to stress that the results obtained herein indeed point to an acute necessity to test, down to the weakest discernible effect, the actual dependence of the force of interaction between parallel current-carrying wires with the distance between them. The existence of a dependence similar to that obtained in eqn.48 would then validate the present theory and would mean that the very basic mechanism by which Ampere's force is exerted may have been found at last in the principles of the theory examined in the present work. It is also worth noting that in fact today's science does not offer any explanation at all regarding the origin of this force, this state of affairs being traceable down to Ampere himself, who was well known for his refraining from giving any possible reason for the effect he discovered. [16] This questionable attitude was unfortunately adopted since then by a great number of prominent scientific investigators. One among them, H. A. Lorentz is worth quoting for his words give one of the best description of this rather strange method of investigating the elecrodynamic phenomena (italics have been added to emphasize the above): [17]

“As to its physical basis, the theory of electrons is an off-spring of the great theory of electricity to which the names of Faraday and Maxwell will be for ever attached.

You all know this theory of Maxwell, which we may call the general theory of the electromagnetic field, and in which we constantly have in view the state of the matter or the medium by which the field is occupied. While speaking of this state, I must immediately call your attention to the curious fact that, although we never lose sight of it, *we need by no means go far in attempting to form an image of it* and, in fact, we cannot say much about it. It is true that we may represent to ourselves internal stresses existing in the medium surrounding an electrified body or a magnet, that we may think of electricity as of some substance or fluid, free to move in a conductor and bound to positions of equilibrium in a dielectric, and that we may also conceive a magnetic field as the seat of certain invisible motions, rotations for example around the lines of force. All this has been done by many physicists and Maxwell himself has set the example. Yet, it must not be considered as really necessary; *we can develop the theory to a large extent and elucidate a great number of phenomena, without entering upon speculations of this kind*. Indeed, on account of the difficulties into which they lead us, there has of late years been a tendency to avoid them altogether and to establish the theory on a few assumptions of a more general nature.

The first of these is, that in an electric field there is a certain state of things which gives rise to a force acting on an electrified body and *which may therefore be symbolically represented by the force acting on such a body per unit of charge*. This is what we call the electric force, *the symbol for a state in the medium about whose nature we shall not venture any further statement*. The second assumption related to a magnetic field. Without thinking about those hidden rotations of which I have just spoken, we can define this by the so called magnetic force, i.e. the force acting on a pole of unit strength.”

It is then not surprising at all after seeing the above words why any attempt to understand the mechanism by which the force in Ampere’s effect is exerted has been abandoned completely. For, having substituted the reality of the aether field with symbols as Lorentz confessedly did, the underlying principles of electrodynamics have been voluntarily hidden under the curtain of these symbols. Thus, the lack of knowledge regarding the nature of magnetic force has been perpetuated ever since and the result that we see today is that physics erroneously gives to the interaction of Ampere’s effect the status of a fundamental force, being commonly known as Lorentz force after the name of the above investigator, probably as a tribute for his contribution of having transposed the Ampere’s force to the case of free, unbound, charges. [18]

Summary and Conclusions

The present work analyzed the electrodynamic phenomena at their microscopic scale. The electric charges, more accurately described as fragments of broken chemical bonds, were considered to move through the outer circuit of a chemical cell by assuming that they entrain the aether in their movement. This led not only to confirmation of the time dependence of the intensity of the current during the transient period, but also to a satisfactory explanation of the effects of attraction and repulsion observed between two parallel conductors carrying stationary currents.

The aether was taken to have the minimal property of an ideal infra-gas that fills the Torricellian vacuum or the interstellar space. Introduction of viscosity or of other properties for the aether were not necessary and the electric charges were assumed to behave as solid bodies that move with friction though the aethereal fluid and set it in motion by generating aether wakes.

Ampere's law giving the force of interaction between electric currents was discussed and a microscopic explanation was given for the forces that are experimentally observed between two parallel, current-carrying conductors. This explanation based on the fluid dynamics of the aether led to a remarkably accurate confirmation of the dependence of the force with the inverse of the distance between the two conductors. This result implies that the magnetic force cannot be considered a fundamental force of nature and that the notion of magnetic field should be more appropriately called dynamic aether field, on grounds that it conveys more accurately the reality of the phenomena.

Calculations based on the present theory revealed the existence of supplementary terms in the expression of the force between current-carrying conductors. These terms are missing in the original law of Ampere and correspond to the behavior of matter in magnetic fields. Obtaining the force of interaction between current-carrying conductors in such a complete form comes to offer further evidence that the present theory is tenable and its principles are applicable to all electrodynamic phenomena.

References

1. Ionel Dinu, "What's Behind Faraday's Magnetic Lines of Force", Electric Spacecraft Journal, Issue 41, 2006.

2. Ionel Dinu, "The Origin of Gravitation", General Science Journal, Jan. 19, 2007.

3. Alessandro Volta, “On the Electricity Excited by the mere Contact of Conducting Substances of Different kinds”, Como, March 20, 1800, a letter to Sir Joseph Banks published in The Philosophical Magazine, September, 1800.
4. John Frederic Daniell, *An Introduction to the Study of Chemical Philosophy*, (John W. Parker, West Strand, London, 1839), art. 746, p. 443.
5. George Gabriel Stokes, *Mathematical and Physical Papers, Vol. III*, (Cambridge: At the University Press, 1901), 59.
6. Edwin B. Kurtz, George F. Corcoran, *Introduction to Electric Transients*, (New York: John Wiley & Sons, Inc., London: Chapman & Hall, Limited, 1935), 17.
7. Ludwig Prandtl, *Essentials of Fluid Dynamics, with Applications to Hydraulics, Aeronautics, Meteorology and Other Subjects*, authorized translation in English (Blackie and Son, Ltd., Glasgow, 1952), 184.
8. E. T. Whittaker, *A History of the Theories of Aether and Electricity from the Age of Descartes to the Close of the Nineteenth Century*, (Longmans Green and Co., London, 1910), 349.
9. Horace Lamb, *Hydrodynamics*, 6th Edition, 6.
10. Ludwig Prandtl, op. cit., 185.
11. Ludwig Prandtl, op. cit., 38.
12. Daniel Bernoulli, *Hydrodynamica, sive de viribus et motibus fluidorum commentarii. Opus academicum ab auctore, dum Petropoli ageret, congestum*, Argentorati, sumptibus Johannis Reinholdi Dulseckeri, Typis Joh. Henr. Deckeri, Typographi Basiliensis 1738, 263.
13. Andre-Marie Ampere, *Theorie Mathematique des Phenomenes Electro-Dynamiques Uniquement Deduite de l’Experience*, (Editions Jacques Gabay, Paris, 1990), 240. (Reproduction of the original Memoire of Andre-Marie Ampere appeared in Paris, Firmin Didot, 1827 and in *Memoires de l’Academie des Sciences de l’Institut de France*, Tome VI, 175-388, 1823.)
14. James Clerk Maxwell, *A Treatise on Electricity and Magnetism*, (London: Macmillan and Co., 1873), vol.ii, 151.
15. James Clerk Maxwell, op. cit., 162,163.
16. Andre-Marie Ampere, op. cit., 177, 178.
17. Hendrik Antoon Lorentz, *The Theory of Electrons and Its Applications to the Phenomena of Light and Radiant Heat*, (Leipzig: B.G. Teubner; New York: G.E. Stechert & Co., 1909), 1-2.
18. ibid., 14.

Figures

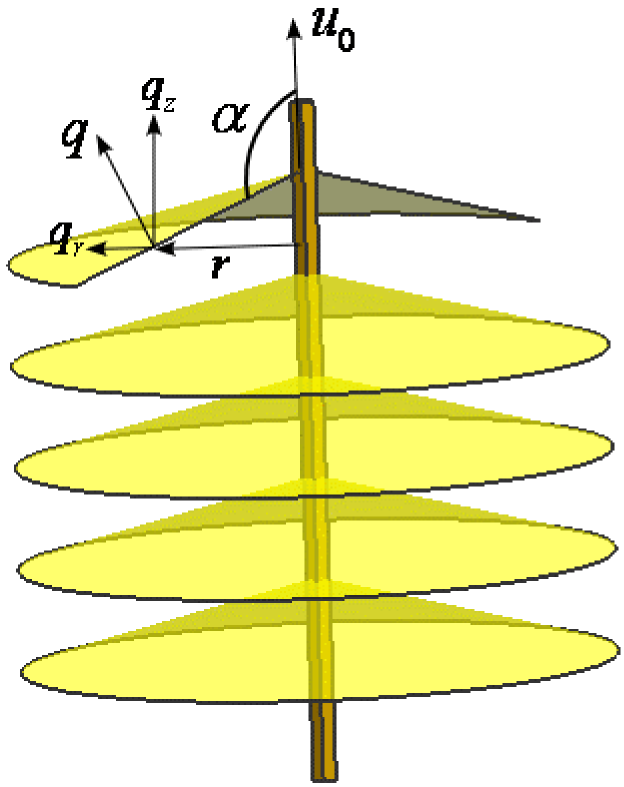

Fig.1. The electric charges moving along the conductor at a certain moment displace the aether existing in their path and send a fraction of it away from the wire in the form of a wake that makes a fixed angle α with the direction of the conductor.

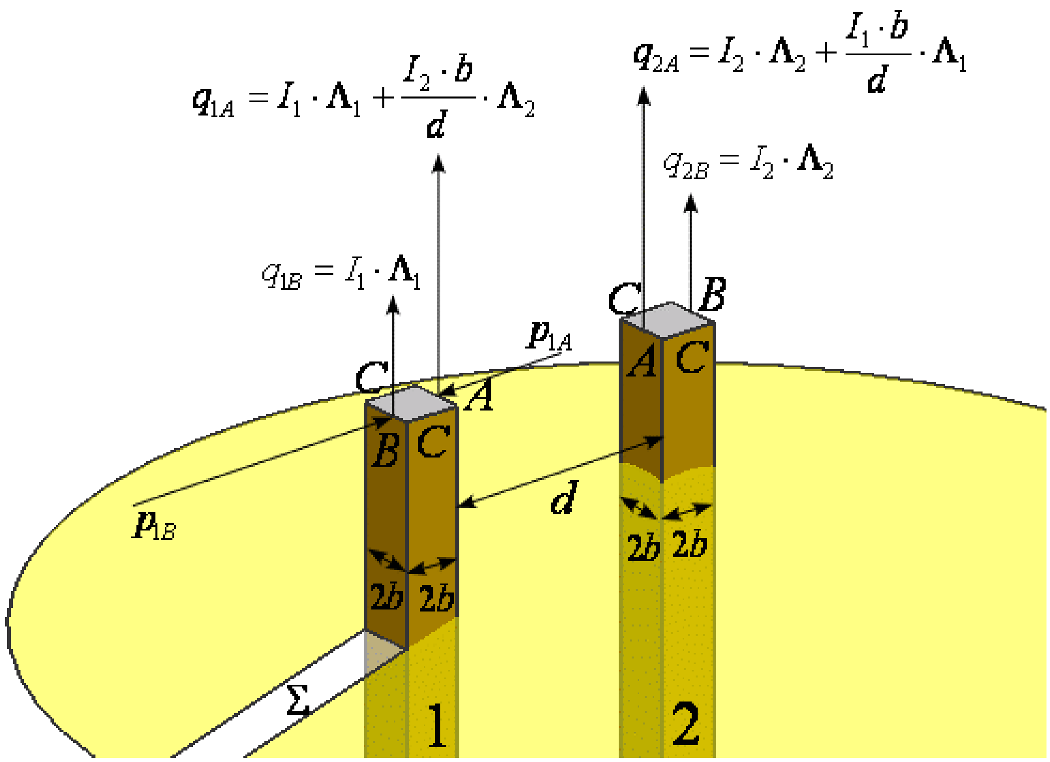

Fig. 2. Two conductors carrying currents in the same direction. The wires have been sectioned to ease representation. The surface Σ shows the effect of screening that the current and the substance of wire 1 has upon the aether wake (yellow) generated by the charges flowing in wire 2. This causes the aether speed around wire 1 to differ at its opposing faces A and B. Bernoulli equation applied to the flow of aether along the wire 1 explains the difference in the static aether pressures that build up on the respective faces and therefore the force of attraction that is observed between two parallel current-carrying wires. The existence of a force of repulsion between wires carrying currents in opposite directions is explained by the same principle.