

Electricity and Magnetism: A Return to Aether

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This paper proposes a physical model of electromagnetic fields. The model draws upon the works of James Clerk Maxwell. It is based upon the proposition that the medium of aether that Maxwell believed existed, does in fact exist. This paper posits that aether consists of highly elastic cells that collide with each other. It ties the interaction of aether cell collisions to the transmission of electricity and magnetism.

1. Introduction

What is an electromagnetic field? What actually goes along a conductor at close to the speed of light when a light switch is pressed and a light bulb is illuminated some distance away? Why does a magnetic field surround a wire that is carrying electricity? Is light both particulate and a wave?

Surely, these questions must have been definitively answered. After all, the advances of science and technology over the past century have been astounding. However, these questions have not been answered. Why not? In the author's opinion, the dominant reason lies in the prevailing wisdom that aether does not exist. Ever since the general acceptance of Einstein's Special Theory of Relativity and, in particular, his expressed view that there is no need for aether, the concept of aether has fallen into general disuse by mainstream science. Physicist David Griffiths puts it this way [1]:

"Special relativity has forced us to abandon the notion of ether, and with it Maxwell's mechanical interpretation of electromagnetic fields. (It is even possible, though cumbersome, to formulate classical electrodynamics as an "action-at-a-distance" theory, and dispense with the field concept altogether). I can't tell you, then, what a field *is* — only how to calculate it and what it can do for you once you've got it."

Richard Feynman illustrates the same prevailing turn of mind in his assertion that [2]:

"The best way is to use the abstract field area. That it is abstract is unfortunate, but necessary. The attempts to try to represent the electric field as the motion of some kind of gear wheels, or in terms of lines, or of stresses in some kind of material have used up more effort of physicists than it would have taken simply to get the right answers about electrodynamics."

There is no doubt that the concept of "field" has proven useful to the development of present day science. However, it begs the question of what is happening inside the field. What are its constituent parts? How do they work?

As generally accepted science still does not provide definitive answers to the questions posed by this paper, it is respectfully suggested that the time has come to reconsider whether in fact aether does exist, and whether the prevailing wisdom of the 19th century, based upon the premise of the existence of aether, can

provide useful guidance to help resolve these fundamental questions.

During the 19th century and earlier, the concept of aether was generally accepted physics. The advent of Dr. Thomas Young's two-slit experiment demonstrated that light was a wave through a medium. His experiment remains today as a powerful testament that there must be a medium through which electromagnetic waves travel.

This paper proposes a physical explanation for electromagnetic fields. In doing so, it looks back to the works of the 19th century physicist, James Clerk Maxwell, and suggests that his theory of electromagnetic fields, based upon the existence of aether, laid down important foundations of electromagnetism.

2. Aether

The idea of aether is certainly not new. Isaac Newton in his treatise *Opticks* raised the question of whether a highly elastic substance that he called Aether pervades the universe and by its vibrations was capable of transmitting heat and light. In the words of Newton [3]:

"Is not the Heat of the warm Room convey'd through the *Vacuum* by the Vibrations of a much subtler Medium than Air, which after the Air was drawn out remained in the *Vacuum*? And is not this Medium the same with that Medium by which Light is refracted and reflected, and by whose Vibrations Light communicates Heat to Bodies, and is put into Fits of easy Reflexion and easy Transmission? And do not the Vibrations of this Medium in hot Bodies contribute to the intenseness and duration of their Heat? And do not hot Bodies communicate their heat to contiguous cold ones, by the Vibrations of this Medium propagated from them into the cold ones? And is not this Medium exceedingly more rare and subtle than the Air, and exceedingly more elastick and active? And doth it not readily pervade all Bodies? And is it not (by its elastick force) expanded through all the Heavens?"

James Clerk Maxwell was of the view that there must be such a substance as aether. He saw it as a medium that carries electromagnetic waves. In his classic essay, "The Dynamical Theory of the Electromagnetic Field", Maxwell said [4]:

"It appears therefore that certain phenomena in electricity and magnetism lead to the same conclusion as those of optics, namely, that there is an ethereal medium pervading all bodies, and modified only in degree by their presence; that the

parts of this medium are capable of being set in motion by electric currents and magnets; that this motion is communicated from one part of the medium to another by forces arising from the connections of those parts; ..."

Maxwell hypothesized that the constituent "parts" of aether are flexible and complex, such that collectively they act as a medium that carries a variety of electromagnetic waves. In his words [4, para. 16]:

"Thus, then, we are led to the conception of a complicated mechanism capable of a vast variety of motion, but at the same time so connected that the motion of one part depends, according to definite relations, on the motion of other parts, these motions being communicated by forces arising from the relative displacement of the connected parts, in virtue of their elasticity."

Despite the present-day prevailing view that aether does not exist, this view is far from unanimous. In fact, there are many notable 20th and 21st century scientists who contend that there is an aethereal medium that occupies space. Here are some examples:

- Paul Dirac, a Nobel Laureate in physics (1933). In a letter published in *Nature* in 1951, entitled "Is there an Aether?", Dirac opined, with supporting reasons, that aether must exist [5].
- Herbert E. Ives, recipient of the Rumford Medal in 1951 for outstanding contributions to the sciences of heat and light. In his paper entitled "Genesis of the Query 'Is there an Aether?'" published in 1953, Ives set out reasons for the existence of aether [6].
- Maurice Allais, Nobel Laureate in Economics (1988). In his book, *L'Anisotropie de L'Espace*, (1997), he gives detailed reasons why there must be "ether" and argues that it is what present-day scientists call a "field" [7].
- Stephen Wolfram, in his work entitled *A New Kind of Science*, published in 2002, speaks of space being a "giant network of nodes" or "cells" [8].
- Patrick Cornille, in his book *Advanced Electromagnetism and Vacuum Physics*, published in 2003, sets out his analysis of why "ether" must exist [9].
- Robert B. Laughlin, Nobel Laureate in physics (1998). In his book, *A Different Universe*, published in 2005, Laughlin expresses the view that a form of matter, that he calls "stuff" and "relativistic ether", permeates space [10].
- Reginald Cahill, in his book *Process Physics: From Information Theory to Quantum Space and Matter*, published in 2005, states that a "quantum foam" forms the substructure of space [11].
- Frank Wilczek, a Nobel Laureate in physics (2004). In his book *The Lightness of Being — Mass, Ether, and the Unification of Forces*, published in 2008, he says that space is filled with a substance. He uses the word "Grid" for this substance [12].

The following excerpts from the works of three of the above scientists illustrate the nature of the aether that this paper posits.

Stephen Wolfram in his book, *A New Kind of Science*, published in 2002 [8]:

"In the last section I argued that if the ultimate model of physics is to be as simple as possible, then one should expect that all the features of our universe must at some level emerge purely from properties in space. But what should space be like if this is going to be the case?"

"The discussion in the section before last suggests that for the richest properties to emerge there should in a sense be as little rigid underlying structure built in as possible. And with this in mind I believe that what is by far the most likely is that at the lowest level space is in effect a giant network of nodes.

"In any array of cells in a cellular automaton each cell is always assigned some definite position. And indeed, the only thing that is defined about each node is what other nodes it is connected to.

"Yet despite this rather abstract setup, we will see that with a sufficiently large number of nodes it is possible for the familiar properties of space to emerge -- together with other phenomena seen in physics."

Robert Laughlin in his book, *A Different Universe*, published in 2005 [10]:

"Relativity actually says nothing about the existence or nonexistence of matter pervading the universe, only that any such matter must have relativistic symmetry.

"It turns out that such matter exists. About the time relativity was becoming accepted, studies of radioactivity began showing that the empty vacuum of space had spectroscopic structure similar to that of ordinary quantum solids and fluids. Subsequent studies with large particle accelerators have now led us to understand that space is more like a piece of window glass than ideal Newtonian emptiness. "It is filled with "stuff" that is normally transparent but can be made visible by hitting it sufficiently hard to knock out a part. The modern concept of the vacuum of space, confirmed every day by experiment, is a relativistic ether. But we do not call it this because it is taboo."

Frank Wilczek in his book, *The Lightness of Being - Mass, Ether and the Unification of Forces*, published in 2008 [12]:

"What is the world made of? Subject, as ever, to addition and correction, here is the multifaceted answer that modern physics provides:

- "The primary ingredient of physical reality, from which all else is formed, fills space and time.
- "Every fragment, each space-time element, has the same basic properties as every other fragment.
- "The primary ingredient of reality is alive with quantum activity. Quantum activity has special characteristics. It is spontaneous and unpredictable. And to observe quantum activity, you must disturb it.
- "The primary ingredient of reality also contains enduring material components. These make the cosmos a multi-layered, multicolored superconductor.
- "The primary ingredient of reality contains a metric field that gives space-time rigidity and causes gravity.

- “The primary ingredient of reality weighs, with a universal density.

“These are words that capture different aspects of this answer: *Ether* is the old concept that comes closest, but it bears the stigma of dead ideas and lacks several of the new ones. *Space-time* is logically appropriate to describe something that is unavoidably *there*, everywhere and always, with uniform properties throughout. But *space-time* carries even more baggage, including a heavy suggestion of emptiness. *Quantum field* is a technical term that summarizes the first three aspects, but it doesn’t include the last three and it sounds, well, too technical and forbidding for use in natural philosophy.

“I will use the word *Grid* for the primary world-stuff.”

There is a body of opinion that the Michelson-Morley experiment in 1887 and subsequent interferometry tests establish that there is no such thing as aether. However, there is also a body of opinion that interferometry tests establish that there is in fact an aetherial substance. Cahill, in his book *Process Physics*, goes into considerable detail explaining why the interferometry testing from Michelson-Morley onwards in fact supports the proposition that aether exists [11, pp. 117-148]. A detailed analysis leading to the same result is set out in Maurice Allais’ book *L’Anisotropie de l’Espace* [7].

It is significant that Einstein, despite what he said in his Special Relativity paper in 1905, eventually came to embrace a form of aether. In an address given at the University of Leyden on May 5, 1920, he said [13]:

“Recapitulating, we may say that according to the general theory of relativity space is endowed with physical qualities; in this sense, therefore, there exists an ether. According to the general theory of relativity space without ether is unthinkable; for in such space there not only would be no propagation of light, but also no possibility of existence for standards of space and time (measuring-rods and clocks), nor therefore any space-time intervals in the physical sense. But this ether may not be thought of as endowed with the quality characteristic of ponderable media, as consisting of parts which may be tracked through time. The idea of motion may not be applied to it.”

In summary, this author suggests that it is reasonable to postulate the existence of a subatomic substance that permeates the universe. It is of little or no importance to the proposals set out in this paper whether this substance is called “grid”, “stuff”, “relativistic ether”, “quantum foam”, “net work of nodes or cells”, “etherial medium”, “field”, “ether” or the word chosen for use in this paper – “aether”.

3. The Essential Thesis

This paper posits that aether cells are highly elastic, and their elasticity causes them to shrink and expand when they collide with other aether cells. This characteristic permits aether to transmit electric and magnetic forces and act as an electromagnetic field.

Visualize a single aether cell being subjected to an electromotive force, such as that produced by an electric battery. Because

of the elasticity of the cell, the electromotive force squeezes the cell from front-to-back. In the same instant, the sides of the cell bulge. Then, in the next instant, the cell’s elasticity causes the cell to expand from front-to-back and shrink around its sides.

Consider next a line of cells. The electromotive force applied to the first cell causes it to collide with the next cell, and collisions continue down the line of cells. Think of these successive collisions of aether cells as the transmission of electric force.

Next, picture the line of aether cells surrounded on all sides by more aether cells. The same electromotive force is now applied to the line of cells. As these cells shrink and expand in the direction of the electromotive force, the cells are caused to bulge and shrink at their sides. The bulging and shrinking at their sides causes them to collide with the surrounding aether cells and thereby transmit force to them. This occurs at right angles to the direction of the electric force. Think of this lateral force as the source of the magnetic field that surrounds a conductor that is carrying an electric current.

To visualize what is occurring, it is helpful to consider the analogue of ordinary rubber balls. To start with, consider a single rubber ball and picture it being struck by a hammer. As the ball is struck, the force of the hammer squeezes the ball. At the same instant, the sides of the ball are caused to bulge. The bulging is at right angles to the line on which the hammer strikes the ball. In the next instant, the elasticity of the ball causes its shape to change. The ball expands along the line it was struck and, as this happens, the sides of the ball shrink.

The deformation of the rubber ball along the line of the applied force is located at the front and back portions of the ball, while the bulging and shrinking at the sides of the ball occur around the ball’s full 360° circumference.

Consider next several rubber balls in a straight line. When the first in line is struck by a hammer, this causes front-to-back collisions along the line of the balls as the hammer’s energy is transferred from ball to ball to ball.

Now let’s add some more rubber balls, this time surrounding the line of balls. When the hammer strikes the first ball in the line, there will be a different transmission of the hammer’s energy. While part of the hammer’s energy will be transferred along the line of balls, part of the force will be transmitted at right angles to the balls surrounding the line of balls.

The rubber balls analogue is, of course, quite simplistic. Aether cells may or may not be shaped like globes and may or may not be immediately adjacent to each other. However, the analogue provides a general picture that makes mechanical sense.

With the analogue in mind, let’s consider a conductor that is carrying an electric current and the magnetic field that surrounds the conductor. Visualize electromotive force causing front-to-back collisions of aether cells along the conductor – in other words, an electric current. Now, visualize the sides of these aether cells springing in and out and colliding with aether cells that surround the conductor. These collisions transmit force that is perpendicular to the direction of the electric current. Here is the source of the magnetic field that surrounds the conductor.

In summary, the successive elastic collisions of aether cells along a conductor is seen as electric current, and collisions of

aether cells that surround the conductor and proceed at right angles to the conductor is seen as the source of the magnetic field that encircles a conductor that is carrying electric current. The array of aether cells in which these collisions are taking place is seen as an electromagnetic field.

Can this model operate in reverse and translate magnetic force into electric current? In other words, is the concept consistent with the phenomenon of induction? The answer must be yes. The elasticity characteristic of aether cells allows the process to work in both directions, depending upon where the initiating force comes from.

Let's return to the questions posed in the introduction.

What is an electromagnetic field? Proposed answer: An electromagnetic field is an array of highly elastic aether cells through which electric and magnetic forces are transmitted.

What actually goes along a conductor, at close to the speed of light, when a light switch is actuated and a light bulb, some appreciable distance away, illuminates almost instantaneously? Proposed answer: Electric energy is transmitted by successive collisions of aether cells along the conductor.

Why does a magnetic field surround a conductor that is carrying an electric current? Proposed answer: When aether cells are subjected to collisions in the direction of an electric current, the cells expand and contract at their sides, causing magnetic force to spread out at right angles to the conductor.

Does the aether model proposed by this paper provide an answer to the wave-particle dichotomy? Proposed answer: Yes, it does. The aether cells that are subjected to successive collisions do not travel from source to destination. Rather, they act like dominoes in the sense that although they strike each other one after the other, they remain essentially in place. Thus, it is the waves (the successive collisions) that move at the speed of light, not the cells themselves.

4. James Clerk Maxwell

The essential thesis of this paper is mainly based upon Maxwell's theory of electromagnetism. Set out below are a number of excerpts from Maxwell's essay, "The Dynamical Theory of the Electromagnetic Field" [4], and his book, **A Treatise on Electricity & Magnetism** [14]. The quoted passages set forth propositions that are based upon the existence of aether. If aether is revived by present-day science, then the propositions formulated by Maxwell again become important considerations in the search for answers to fundamental questions that continue to elude present-day science.

Passages from Maxwell's **The Dynamical Theory of The Electromagnetic Field**:

"The theory I propose may therefore be called a theory of the *Electromagnetic Field*, because it has to do with the space in the neighbourhood of the electric or magnetic bodies, and it may be called a *Dynamical Theory*, because it assumes that in that space there is matter in motion, by which the observed electromagnetic phenomena are produced." [4, para. 3]

"There is always, however, enough of matter left to receive and transmit the undulations of light and heat, and it is because the transmissions of these radiations is not greatly al-

tered when transparent bodies of measurable density are substituted for the so-called vacuum, that we are obliged to admit that the undulations are those of an ethereal substance and not of the gross matter, the presence of which modifies in some way the motion of the ether." [4, para. 4]

"We have therefore reason to believe, from the phenomena of light and heat, that there is an ethereal medium filling space and permeating bodies, capable of being set in motion and of transmitting that motion from one part to another, and of communicating that motion in gross matter so as to heat it and affect it in various ways." [4, para. 4]

"Hence the parts of the medium must be so connected that the motion of one part depends in some way on the motion of the rest; and at the same time these connections must be capable of a certain kind of elastic yielding, since the communications of motion is not instantaneous, but occupies time." [4, para. 6]

"It appears therefore that certain phenomena in electricity and magnetism lead to the same conclusion as those of optics, namely, that there is an ethereal medium pervading all bodies, and modified only in degree by their presence; that the parts of this medium are capable of being set in motion by electric currents and magnets; that this motion is communicated from one part of the medium to another by forces arising from the connections of those parts; that under the action of these forces there is a certain yielding depending on the elasticity of these connections..." [4, para. 15]

"Thus, then, we are led to the conception of a complicated mechanism capable of a vast variety of motion, but at the same time so connected that the motion of one part depends, according to definite relations, on the motion of other parts; these motions being communicated by forces arising from the relative displacement of the connected parts, in virtue of their elasticity." [4, para. 16]

Passages from Maxwell's **A Treatise of Electricity and Magnetism**:

"The electric polarization of an elementary portion of a dielectric is a forced state into which the medium is thrown by the action of electromotive force, and which disappears when that force is removed. We may conceive it to consist in what we may call an electric displacement, produced by the electromotive intensity." [14, para. 60]

"The analogy between the action of electromotive intensity in producing electric displacement and of ordinary mechanical force in producing the displacement of an elastic body is so obvious that I have ventured to call the ratio of the electromotive intensity to the corresponding electric displacement the *coefficient of electric elasticity* of the medium." [14, para. 60]

"The variations of electric displacement evidently constitute electric currents. These currents, however, can only exist during the variation of the displacement..." [14, para. 60]

"That whatever electricity may be, and whatever we may understand by the movement of electricity, the phenomenon which we have called electric displacement is a movement of electricity in the same sense as the transference of a definite

quantity of electricity through a wire is a movement of electricity, the only difference being that in the dielectric there is a force which we have called electric elasticity which acts against the electric displacement, and forces the electricity back when the electromotive force is removed..." [14, para. 62]

"The distribution of stress considered in this chapter is precisely that to which Faraday was led in his investigation of induction through dielectrics. He sums up in the following words [14, para. 109]:

"(1297) The direct inductive force, which may be conceived to be exerted in lines between the two limiting and charged conducting surfaces, is accompanied by a lateral or transverse force equivalent to a dilatation or repulsion of these representative lines (1224); or the attractive force which exists amongst the particles of the dielectric in the direction of the induction is accompanied by as repulsive or a diverging force in the transverse direction.

"(1298) Induction appears to consist in a certain polarized state of the particles, into which they are thrown by the electrified body sustaining the action, the particles assuming positive and negative points or parts, which are symmetrically arranged with respect to each other and the inducing surfaces or particles. The state must be a forced one, for it is originated and sustained only by force, and sinks to the normal or quiescent state when that force is removed..." [15]

"At every point of the medium there is a state of stress such that there is tension along the lines of force and pressure in all directions at right angles to these lines..." [14, para. 110]

"In fact, whenever energy is transmitted from one body to another in time, there must be a medium or substance in which the energy exists after it leaves one body and before it reaches another..." [14, para. 866]

5. Summary of Maxwell Propositions

The following is a summary of the propositions set out in the above-quoted excerpts from the works of James Clerk Maxwell:

- A sub-atomic substance called aether exists;
- It consists of parts or particles. In this paper they are called "cells";
- The cells are highly elastic;
- The cells are capable of being systematically arranged in respect of each other;
- Electromotive force causes the cells to act in concert and do so under stress and tension;
- The stress and tension is called displacement;
- Electric current consists of variations of electric displacement of adjacent aether cells;
- Electric displacement is a mechanical process;
- Electric current transmits forces in the direction of the current and at right angles to the current;
- Magnetic force surrounds a conductor at right angles to electric current along the conductor;

- Induction occurs by energy being transmitted through aether cells;
- When no electric force is being transmitted, aether cells return to their normal or quiescent state.

6. Limits Placed by Maxwell on His Aether Theory

In stating his aether theory of the electromagnetic field, Maxwell was aware that the extent of his theory was limited. He said:

"It must be carefully borne in mind that we have made only one step in the theory of the action of the medium. We have supposed it to be in a state of stress, but we have not in any way accounted for this stress, or explained how it is maintained. This step, however, seems to me to be an important one, as it explains, by the action of the consecutive parts of the medium, phenomena which were formerly supposed to be explicable only by direct action at a distance." [14, para. 110]

Maxwell went on to describe what he saw as the "next step". He said:

"I have not been able to make the next step, namely, to account by mechanical considerations for these stresses in the dielectric." [14, para. 110]

It is in regard to the mechanics of the medium of aether that this paper proposes as a "next step" the propositions set out in the essential thesis section above.

7. Experiments

The rubber ball analogue invites simple and inexpensive experimentation. The application of force to elasticized balls or objects placed in various positions in relation to each other, along with suitable energy detection equipment, should either lend credence to or perhaps falsify the proposals set out in this paper. Such experimentation may well indicate the nature of the transfer of forces, including their directions and intensities.

8. Conclusion

In summary, this paper proposes a return to aether as a medium in which electromagnetic phenomena operate. It advocates a return to Maxwell's works to explain electromagnetic phenomena. It argues that aether consists of aether cells and uses the rubber ball analogue to illustrate the mechanism by which aether transmits electric and magnetic forces. The paper proposes experiments that might support or falsify the proposals and provide useful information about the transmission of electromagnetic forces.

In closing, it should be noted that the scope of the proposals in this paper is limited in the sense that there are numerous open questions that this paper does not purport to address. They include: What accounts for the attraction and repulsion of magnetism? What precisely are positive and negative charges? What is polarization of light? What parts do electrons and protons play in the transmission of electricity? Do aether cells contain energy? These and other fundamental questions remain to be answered.

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