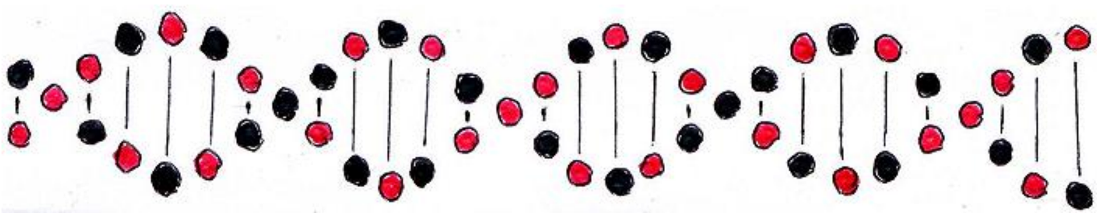
the general science journal

An Interpretation of Faraday's Lines of Force

Frederick David Tombe
Belfast, Northern Ireland,
United Kingdom,
sirius184@hotmail.com
7th April 2019



Abstract. The magnetic field is solenoidal, yet the Biot-Savart Law, which is the textbook equation for the magnetic field, indicates the existence of a singularity owing to the fact that it involves an inverse square law in distance. This dilemma is solved within the context that an individual magnetic line of force constitutes a double helix of sinks and sources closed on itself to form a toroidal ring vortex.

The Double Helix Theory of the Magnetic Field

I. We saw in ***"The Double Helix Theory of the Magnetic Field"*** **[1]**, how rotating electron-positron dipoles could be arranged in a double helix fashion so as to account for the magnetic field. A rotating electron-positron dipole consists of an electron and a positron undergoing a mutual central force orbit such that the rotation axis is perpendicular to a line joining the electron to the positron. If we stack these dipoles on top of each other along their axes of rotation with the electrons placed approximately above the positrons and angularly synchronized in a twisted rope ladder fashion, we will effectively have a helical spring. These helical springs are magnetic lines of force by virtue of the fact that they channel a Coulomb tension along a double helix alignment within a neutral electron-positron sea. See Figure 1 below. The angular momentum vector **H** within these rotating dipoles is a measure of the magnetic intensity of the lines of force. The rotating dipoles in one line of force will be aligned in their mutual equatorial planes with the rotating dipoles in an adjacent line of force and the mutual transverse velocities existing between them will cause a centrifugal repulsion that will push them apart as explained in section **II** below. Since the magnetic lines of force between two like poles do not join directly together, but instead spread outwards and contact each other laterally, magnetic repulsion occurs due to centrifugal force.

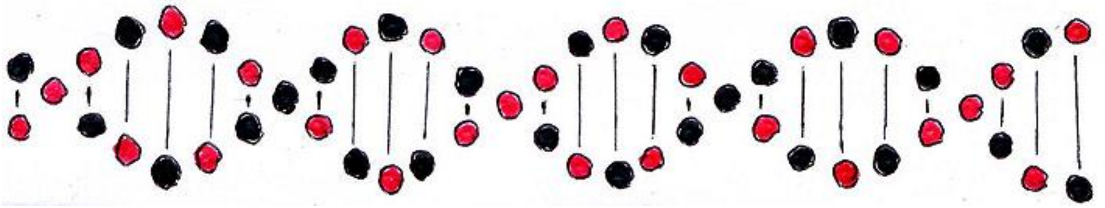


Figure 1. A close-up view of a single magnetic line of force. The electrons are shown in red and the positrons are shown in black. The double helix is rotating about its axis which represents the magnetic intensity vector H. The diagram is not to scale as the relative dimensions remain uncertain. The circumferential speed of the electrons and positrons is what determines the local speed of light.

Centrifugal Force and Magnetic Repulsion

II. Consider two electron-positron dipoles sitting side by side while rotating in the same plane and in the same direction. When the electron of one dipole passes the positron of the other dipole in the opposite direction at closest approach, the electrostatic field lines will connect directly between the two. According to Coulomb's law there should be a force of attraction acting between them as in the case of any two particles of opposite charge. However, in this case the two particles will possess an enormous mutual transverse speed, and this gives us reason to believe that the Coulomb force of attraction would be undermined. This would be so if the electrostatic force field **E** is fluid based, because above a certain threshold of mutual angular speed, the inevitable curl in the associated velocity field would split this field between the two rotating dipoles. And if this happens it will necessarily convert the electrostatic attraction into a repulsion. The **E** field lines may remain irrotational, but their physical cause will have changed. It will no longer be due to a tension in the fluid but instead it will be due to side pressure from the flow lines, and so we will now be dealing with centrifugal force as opposed to the Coulomb force. The proof that such a fluid exists lies in the ability to explain magnetic repulsion and Ampère's Circuital Law in terms of its curl. Time varying electromagnetic induction can then be explained in terms of a curl in the **E** field. We can call it the *aether* or the *electric fluid,* but it is the primary fluid from which all matter is made. And if this fluid exists then it should be obvious that particles are sinks or sources in it. As a convention, electrons will be considered to be aether sinks while positrons are aether sources.

Electric current cannot be fully understood in the absence of a primary fluid flow at a deeper level than the flow of charged particles. Electrons would eat their way upstream in such a fluid while positrons would be pushed in the opposite direction, and if the fluid were inviscid, charged particles would be accelerated by the fluid due to pressure or tension but without taking on the fluid's actual velocity. Electric signals in a conducting wire travel at a speed that is in the same order as the speed of light which is probably the speed of the electric fluid.

Ampère's Circuital Law

III. When rotating electron-positron dipoles bond together along their rotation axes to form a double helical toroid with nothing in the toroidal hole in the middle, the Coulomb attraction along the double helix would tend to make the helix collapse. If the circumferential speed of each rotating dipole is $\mathbf{v}$, then $\nabla\times\mathbf{v} = \mathbf{H}$ where $\mathbf{H}$ is the vorticity, and hence $\nabla\cdot\mathbf{H} = 0$ meaning that $\mathbf{H}$ is solenoidal. The speed $\mathbf{v}$ represents the vortex flow of the electric fluid which constitutes an electric current. At the hole in the middle of the toroid there will be a concentration of electric fluid flowing in one direction, and the current density will be $\rho\mathbf{v} = \mathbf{J}$ where ρ is the fluid density in the hole. The concentration of electric current through the hole in the toroid prevents the toroid from collapsing into the hole. Unlike in the case of fluid pouring down a sink, a toroid involves only solenoidal flow and so the fluid circulates around indefinitely. The fluid cannot pass sideways through itself inside the toroidal hole and so the toroid cannot collapse. The double helix toroid is therefore the fundamental basis for stability and the default alignment in the electron-positron sea. It corresponds to a magnetic line of force and $\mathbf{H}$ corresponds to magnetic intensity. And since $\mathbf{H}$ forms a circle around the inside of the double helix, it follows therefore that $\nabla\times\mathbf{H} = \mathbf{J}$. This is Ampère's Circuital Law which is Maxwell's third equation. See section **V** below.

Within the context that $\mathbf{v}$ corresponds to the circumferential current within the individual rotating dipoles that fill all of space, a vector $\mathbf{A}$ will be defined as $\mu\mathbf{v}$, where μ, known as the magnetic permeability, is a measure of the flux density of magnetic lines of force in the vicinity. In a steady state magnetic field, $\mathbf{A}$ is a fine-grained *circulating current density* (or momentum density) in the electron-positron sea. The product $\mu\mathbf{H}$ is known as the magnetic flux density and written as $\mathbf{B}$. Hence $\nabla\times\mathbf{A} = \mathbf{B}$ and Ampère's Circuital Law becomes $\nabla\times\mathbf{B} = \mu\mathbf{J}$. The equation $\nabla\times\mathbf{A} = \mathbf{B}$ is

Maxwell's second equation from which $\nabla\cdot\mathbf{B} = 0$ can be derived. Maxwell referred to the magnetic vector potential **A** as the *electromagnetic momentum*, and although he invented displacement current, he failed to identify it with **A**.

Ampère's Circuital Law means that when a current or a particle, neutral or otherwise, moves through the electron-positron sea, it causes the electron-positron dipoles to align with their rotation axes forming solenoidal rings around the direction of motion. This provides a circular energy flow mechanism which replaces friction with the inertial forces and magnetic repulsion. It's similar in principle to the creation of smoke rings. Maxwell explains Ampère's Circuital Law at equation (9) in Part I of his 1861 paper ***"On Physical Lines of Force"*** **[2]**.

Ampère's Circuital Law beyond atomic and molecular matter takes the form $\nabla\times\mathbf{B} = \mu\mathbf{A}$, where **A** is net zero in the steady state. From this we can then derive the electromagnetic wave equation **[3]**, **[4]**. In the dynamic state when electromagnetic radiation is passing through, the displacement current, **A**, will be in an oscillating state and there will be a net flow of electric fluid from vortex to vortex travelling at the speed of light **[5]**, **[6]**.

The Biot-Savart Law

IV. Within the context of a single rotating electron-positron dipole, the angular momentum can be written as $\mathbf{H} = \mathbf{D}\times\mathbf{v}$, where **D** is the displacement from the centre of the dipole and **v** is the circumferential velocity. When elastically bonded to other dipoles within the wider electron-positron sea, the displacement **D** will be related to the transverse elasticity through Maxwell's fifth equation, $\mathbf{D} = -\varepsilon\mathbf{E}$, where ε is known as the electric permittivity (see section **V** below including the note on the negative sign). A full analysis can be seen in the article ***"Radiation Pressure and $E = mc^2$"*** **[7]**. If we substitute $\mathbf{D} = -\varepsilon\mathbf{E}$ into $\mathbf{H} = \mathbf{D}\times\mathbf{v}$ this leads to,

$$\mathbf{H} = \varepsilon\mathbf{v}\times\mathbf{E} \qquad \textbf{(1)}$$

Equation **(1)** would appear to be equivalent to the Biot-Savart Law when **E** corresponds to the Coulomb force. However, in the context, **E** will be the centrifugal force, $\mathbf{E} = \mathbf{v}\times\mathbf{B}$, and not the Coulomb force. If we take the curl of equation **(1)** we get,

$$\nabla\times\mathbf{H} = \varepsilon[\mathbf{v}(\nabla\cdot\mathbf{E}) - \mathbf{E}(\nabla\cdot\mathbf{v}) + (\mathbf{E}.\nabla)\mathbf{v} - (\mathbf{v}.\nabla)\mathbf{E}] \qquad \textbf{(2)}$$

Since **v** is not a vector field, this reduces to,

$$\nabla\times\mathbf{H} = \varepsilon[\mathbf{v}(\nabla\cdot\mathbf{E}) - (\mathbf{v}.\nabla)\mathbf{E}] \qquad \textbf{(3)}$$

Since **v** and **E** are perpendicular, the second term on the right-hand side of equation **(3)** vanishes. Finally, the **E** field corresponds to the centrifugal pressure in the equatorial plane within the rotating dipole. This differs from the Coulomb force in that it arises from the curl in the interior **A** field, whereas in Coulomb's law it is the purely radial component of **A** which is significant. The aethereal flow around the positron therefore presses laterally against the aethereal flow around the electron because the flow between the two has been cut, and in both cases has been diverted up and down into the axial direction of the double helix. Nevertheless, **E** is still radial and dependent on the magnitude of the radial flow and so it is safe to suppose that **E** still satisfies Gauss's Law, $\nabla\cdot\mathbf{E} = \rho/\varepsilon$, and hence equation **(3)** becomes,

$$\nabla\times\mathbf{H} = \rho\mathbf{v} = \mathbf{J} \qquad \textbf{(4)}$$

which is Ampère's Circuital Law.

Unlike equation **(1)** above, the Biot-Savart Law is not restricted to the context of a rotating electron-positron dipole. The Biot-Savart law is a vector field function of general application with a polar origin located inside a magnetic source. If we take the curl of the Biot-Savart Law, then owing to its radial position dependence, we obtain $\nabla\times\mathbf{B} = 0$ in the space beyond the source. This gives the false impression that there is no curl in a steady state magnetic field, yet the entire structure and operation of magnetic lines of force is built upon vorticity. The vorticity in a magnetic field is however fine-grained vorticity which is below the radar of the Biot-Savart Law.

Another conundrum is the fact that the divergence of **B** is zero, implying no sinks or sources, yet the entire **B** field is riddled with sinks and sources. These two conundrums can both be resolved by realizing the distinction between **B** in the context of the electron-positron sea on the one hand, and the **B**(r) of the Biot-Savart Law on the other hand. **B** in the electron-positron sea is a *vorticity density* associated with rotating electron-positron dipoles. The curl of **B** in the electron-positron sea is μ**A** and the divergence is zero because **B** is solenoidal. The Biot-Savart Law on the other hand is a position dependent function **B**(r) whereby the zero divergence is based, not on the issue of **B**(r) being solenoidal, but rather on the basis that it is an inverse square law position function in r.

So, although Faraday's lines of force are solenoidal, they are nevertheless pierced at the sides with sources and sinks forming a double helix pattern.

Maxwell's Equations and Summary

V. Maxwell's eight original equations as listed in his 1864 paper entitled ***"A Dynamical Theory of the Electromagnetic Field"*** **[4]**, in a section entitled *'General Equations of the Electromagnetic Field'*, appear in modern format as follows,

Maxwell's Original Eight Equations 1864

(A) The Equation of Total Currents including ***"Displacement Current"***

$\mathbf{J}_{\mathbf{total}} = \mathbf{J}_{\mathbf{conduction}} + \partial\mathbf{D}/\partial t$

(B) The Equation of Magnetic Force

$\nabla\times\mathbf{A} = \mu\mathbf{H}$

(C) The Equation of Electric Current (Ampère's Circuital Law)

$\nabla\times\mathbf{H} = \mathbf{J}_{\mathbf{total}}$

(D) The Equation of Electromotive Force (The Lorentz Force)

$\mathbf{E} = \mu\mathbf{v}\times\mathbf{H} - \partial\mathbf{A}/\partial t - \mathrm{grad}\psi$

(E) The Equation of Electric Elasticity (Hooke's Law)

$\mathbf{D} = \varepsilon\mathbf{E}$

(F) The Equation of Electric Resistance (Ohm's Law)

$\mathbf{E} = R\mathbf{J}_{\mathbf{conduction}}$

(G) Gauss's Law for Free Electricity

$\nabla \cdot \mathbf{D} = \rho$

(H) The Equation of Continuity

$\nabla \cdot \mathbf{J} + \partial \rho / \partial t = 0$

Maxwell's second equation, $\nabla \times \mathbf{A} = \mu \mathbf{H}$, was derived on the basis that **A** is a momentum density from which we can then derive the solenoidal equation $\nabla \cdot \mu \mathbf{H} = 0$ ($\nabla \cdot \mathbf{B} = 0$) that is familiar in the modern listings of four Maxwell's equations. Modern textbooks however reverse the reasoning and work backwards to **A**, giving no physical meaning to **A**, and in the process adding an arbitrary constant of integration and inventing a red herring topic known as *"gauge theory"*.

The Biot-Savart Law is notably absent from the list. Interestingly there is an equation of the form $\mathbf{H} = \varepsilon \mathbf{v} \times \mathbf{E}$ which has a superficial resemblance to the Biot-Savart Law and from which we can derive Ampère's Circuital Law (Maxwell's third equation) simply by taking its curl, but this equation only exists within the context of an electron-positron sea which is not acknowledged to exist by mainstream physicists. The velocity **v** term, where **v** determines the speed of light, is the circumferential velocity of the individual rotating electron-positron dipoles, while **E** is equal to $\mu \mathbf{v} \times \mathbf{H}$. (See the Appendix at the end)

Modern textbooks take the curl of the actual Biot-Savart Law in order to derive Ampère's Circuital Law and this has caused considerable confusion since it leads to the false conclusion that $\nabla \times \mathbf{B} = 0$ in the regions beyond atomic and molecular matter, where in fact we should be using $\nabla \times \mathbf{B} = \mu \mathbf{A}$, where **A** is equal to zero in the steady state.

Not even Maxwell himself realized that the magnetic vector potential **A**, which he termed the *electromagnetic momentum*, in fact corresponds to his very own displacement current. The displacement current was essential in Maxwell's derivation of the electromagnetic wave equation, but he never made the realization that the displacement current is in fact the vector **A**. The general misunderstandings surrounding displacement current is a serious problem which is fudged in the textbooks by adding a ***virtual*** displacement current as an extra term to Ampère's Circuital Law, when in fact the original Ampère's Circuital Law should simply be used in conjunction with the actual displacement current **A** [3]. In a steady state magnetic field, the displacement current **A** is undergoing fine-grained circulation with no net translation, hence $\nabla \times \mathbf{B} = 0$, while in the dynamic state when time varying electromagnetic induction is involved, there is a net translational flow of **A** which constitutes wireless electromagnetic radiation, and hence we have $\nabla\times\mathbf{B} = \mu\mathbf{A}$, where **A** satisfies the simple harmonic equation, $\mathbf{A} = -\varepsilon\partial^2\mathbf{A}/\partial t^2$, hence $\mathbf{A} = \varepsilon\partial\mathbf{E}/\partial t$, where from Faraday's law, $\mathbf{E} = -\partial\mathbf{A}/\partial t$.

Maxwell's fourth equation **(D)** is easily recognizable as the Lorentz force. The three components on the right-hand side of equation **(D)** appeared in equations (5) and (77) in Maxwell's 1861 paper **[1]**. If we take the curl of equation **(D)** we end up with,

$$\nabla\times\mathbf{E} = -(\mathbf{v}.\nabla)\mathbf{B} - \partial\mathbf{B}/\partial t = -d\mathbf{B}/dt \qquad \mathbf{(5)}$$

See **Appendix B** in ***"The Double Helix Theory of the Magnetic Field"*** **[1]** for the full analysis. Equation **(5)** with the convective term $(\mathbf{v}.\nabla)\mathbf{B}$ removed, hence leaving only the partial time derivative $-\partial\mathbf{B}/\partial t$ term, is one of the equations in the modern listings of four Maxwell's equations and it is known as Faraday's Law. It deals only with time varying electromagnetic induction although Faraday's original flux law also takes into account the convective effect $\mathbf{E} = \mathbf{v}\times\mathbf{B}$.

Maxwell's fifth equation is a form of Hooke's Law and it is most relevant in relation to the elasticity of the electron-positron sea. In his 1861 paper where he first introduced the equation in the preamble of Part III and at equation (105), Maxwell uses a negative sign even though he derived it in conjunction with Hooke's Law. It's not clear why he did this, but the negative sign is preferable when we are considering the simple harmonic motion aspect of free oscillations **[2]**.

References

[1] Tombe, F.D., ***"The Double Helix Theory of the Magnetic Field"*** (2006) http://gsjournal.net/Science-Journals/Research%20Papers-Mathematical%20Physics/Download/6371

[2] Clerk-Maxwell, J., ***"On Physical Lines of Force"***, Philosophical Magazine, Volume XXI, Fourth Series, London, (1861) http://vacuum-physics.com/Maxwell/maxwell_oplf.pdf

[3] Tombe, F.D., ***"Displacement Current and the Electrotonic State"*** (2008) http://gsjournal.net/Science-Journals/Research%20Papers-Mechanics%20/%20Electrodynamics/Download/228

[4] Clerk-Maxwell, J., ***"A Dynamical Theory of the Electromagnetic Field"***, Philos. Trans. Roy. Soc. London **155**, pp 459-512 (1865). Abstract: Proceedings of the Royal Society of London 13, pp. 531-536 (1864). The original eight Maxwell's equations are found in the link below in Part III entitled *'General Equations of the Electromagnetic Field'* which begins on page 480,

http://www.zpenergy.com/downloads/Maxwell_1864_3.pdf
Maxwell's derivation of the electromagnetic wave equation is found in the link below in Part VI entitled *'Electromagnetic Theory of Light'* which begins on page 497,
http://www.zpenergy.com/downloads/Maxwell_1864_4.pdf

[5] The 1937 Encyclopaedia Britannica article on *'Ether'* discusses its structure in relation to the cause of the speed of light. It says, *''POSSIBLE STRUCTURE. __* ***The question arises as to what that velocity can be due to. The most probable surmise or guess at present is that the ether is a perfectly incompressible continuous fluid, in a state of fine-grained vortex motion, circulating with that same enormous speed. For it has been partly, though as yet incompletely, shown that such a vortex fluid would transmit waves of the same general nature as light waves _i.e., periodic disturbances across the line of propagation_ and would transmit them at a rate of the order of magnitude as the vortex or circulation speed - - - -"***
http://gsjournal.net/Science-Journals/Historical%20Papers-%20Mechanics%20/%20Electrodynamics/Download/4105

[6] Tombe, F.D., ***"The 1856 Weber-Kohlrausch Experiment"***, (2015)
http://gsjournal.net/Science-Journals/Research%20Papers-Mathematical%20Physics/Download/6314

[7] Tombe, F.D., ***"Radiation Pressure and E = mc²"*** (2018)
http://gsjournal.net/Science-Journals/Research%20Papers-Mathematical%20Physics/Download/7324

Appendix

$\mathbf{H} = \varepsilon\mathbf{v}\times\mathbf{E}$ where $\mathbf{E} = \mu\mathbf{v}\times\mathbf{H}$

$\mathbf{H} = \varepsilon\mu\mathbf{v}\times(\mathbf{v}\times\mathbf{H})$

$|H| = |\varepsilon\mu v^2 H|$ (**v**, **E**, and **H** are mutually perpendicular in the rotating dipole)

$\varepsilon\mu = 1/c^2$

hence $v = c$