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Isotropy in the Electromagnetic Field

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Abstract. **In Part III of his 1861 paper *"On Physical Lines of Force"*, James Clerk Maxwell introduces the concept of displacement current in connection with the elasticity of the medium for the propagation of light. During the course of Part III, the luminiferous medium changes from an anisotropic sea of molecular vortices into an isotropic dielectric solid. An attempt will be made to reconcile these two seemingly contradictory mediums.**

The Magnetic Field

I. In Parts I and II of Maxwell's 1861 paper ***"On Physical Lines of Force"*** **[1]**, he proposes a dense sea of molecular vortices in order to explain electromagnetic phenomena. A magnetic field is an alignment of these vortices such that their mutual rotation axes trace out the lines of force. Tension along the lines of force causes magnetic attraction between unlike poles while centrifugal force acting sideways from the lines of force causes magnetic repulsion between like poles. The magnetic field, being cylindrically symmetric, is therefore an anisotropic structure.

Electrostatics and Elasticity

II. Maxwell links the speed of light to the elasticity of the luminiferous medium through the result of the 1855 Weber-Kohlrausch experiment **[2]**. The speed of light falls out of the ratio between electrostatic units of charge and electromagnetic units of charge, and so this means that magnetism is just as important as electrostatics as regards the source of the elasticity in electromagnetic waves. However, in Part III of Maxwell's 1861 paper, the argument focuses exclusively on dielectric polarization in an electrostatic field. The sea of molecular vortices from which he derived most of his electromagnetic theory seems to give way to a perfect isotropic dielectric solid.

Faraday's ice pale experiment, conducted in 1843, demonstrated that when a point charge is enclosed inside a hollow conducting shell, that an electric field, **E**, causes an equal charge to reside on the outside surface. In the case of a hollow conducting sphere, the charge per surface area, Q/A, known as the

displacement, **D**, will be equal in magnitude to $Q/4\pi r^2$ since $4\pi r^2$ is the surface area of a sphere. The electric displacement **D** is proportional to the electric field that causes it as per the equation $\mathbf{D} = \varepsilon\mathbf{E}$, where ε is the electric permittivity. Hence, the electric field, **E**, emanating from a point charge is equal in magnitude to $Q/4\pi\varepsilon r^2$, which is Coulomb's Law. Having concluded that the elasticity in space is due to the presence of an all-pervading isotropic dielectric solid, Maxwell applied this relationship to the dielectric polarization surrounding a charged sphere, and from the result of the 1855 Weber-Kohlrausch experiment he was able to link the dielectric constant (which is reciprocally proportional to the permittivity) to the speed of light.

The question then remains as to how we can actually have an isotropic dielectric and how it relates to magnetism.

Isotropy

III. By 1865, Maxwell seems to have settled on the dielectric model for the luminiferous medium, but when he came to derive the electromagnetic wave equation in his paper ***"A Dynamical Theory of the Electromagnetic Field"***, he applied Faraday's Law to the argument in section **II** above **[3]**. He combined the electrostatic force with the Faraday force at equation (67) such that the displacement equation became $\mathbf{D} = -\varepsilon(\text{grad}\psi + \partial\mathbf{A}/\partial t)$, where ψ is the electrostatic potential and **A** is the magnetic vector potential. But even though Maxwell's entire argument linking the speed of light to the elasticity was grounded in the irrotational electrostatic field surrounding a point charge, the electrostatic term was eventually eliminated from the derivation of the electromagnetic wave equation. The significant force for that purpose was the dynamic Faraday force, $\mathbf{E} = -\partial\mathbf{A}/\partial t$, which has its origins in the cylindrically symmetric, and hence anisotropic, sea of molecular vortices that Maxwell used in Parts I and II of his 1861 paper. And since curl $\mathbf{A} = \mu\mathbf{H}$, **A** is therefore a transverse momentum in a vortex, and so the Faraday force $\mathbf{E} = -\partial\mathbf{A}/\partial t$ must be a force which causes an angular acceleration. We therefore seem to have lost all basis for assuming that we can transfer Maxwell's electrostatic argument regarding elasticity into the electromagnetic realm. Electrostatics is about linear polarization whereas magnetization is about fine-grained rotation and torque **[4]**.

This problem would be solved however if the molecular vortices were to be rotating electron-positron dipoles, as in each dipole being an electron in mutual orbit with a positron. The tension in magnetic lines of force would then be due to electrostatic tension channelled along a double helix of electrons and positrons **[5]**, **[6]**. This would immediately bring a commonality to the electrostatic and the electromagnetic case scenarios. An electrostatic field would cause the rotating dipoles to precess due to their dipolarity. Precession would be the outcome of linear polarization in the case of when the dipoles are rotating.

Likewise, the angular acceleration caused by the Faraday force $\mathbf{E} = -\partial\mathbf{A}/\partial t$ would have a similar precessional effect and so the reacting elasticity in the dielectric medium would be the same in each case. The luminiferous medium would have an anisotropic structure as regards the magnetic field, yet it would be fully isotropic with respect to the application of an electric field and the propagation of electromagnetic radiation. So long as the primary aethereal substance, **[7]**, has both sinks and sources, it can double for a dielectric and a sea of vortices. It's the fine-grained rotation that enables the dielectric to be isotropic under the action of an electric field. Maxwell was still open to the idea of fine-grained rotation in 1878 when he wrote the article on *"Ether"* for the Encyclopaedia Britannica **[8]**.

References

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

[2] Tombe, F.D., ***"The 1855 Weber-Kohlrausch Experiment"*** (2019)
http://gsjournal.net/Science-Journals/Research%20Papers-Mechanics%20/%20Electrodynamics/Download/7711

[3] 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

[4] Lodge, Sir Oliver, ***"Ether (in physics)"***, Encyclopaedia Britannica, Fourteenth Edition, Volume 8, Pages 751-755, (1937)
http://gsjournal.net/Science-Journals/Historical%20PapersMechanics%20/%20Electrodynamics/Download/4105
In relation to the speed of light, *"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 same order of magnitude as the vortex or circulation speed"*

[5] Tombe, F.D., ***"The Double Helix and the Electron-Positron Aether"*** (2017)
https://www.researchgate.net/publication/319914395_The_Double_Helix_and_the_Electron-Positron_Aether

[6] Tombe, F.D., ***"The Double Helix Theory of the Magnetic Field"*** (2006) Galilean Electrodynamics, Volume 24, Number 2, p.34, (March/April 2013) http://gsjournal.net/Science-Journals/Research%20Papers-Mathematical%20Physics/Download/6371

[7] O'Neill, John J., ***"PRODIGAL GENIUS, Biography of Nikola Tesla"***, Long Island, New York, 15th July 1944, quoting Tesla from his 1907 paper ***"Man's Greatest Achievement"*** which was published in 1930 in the Milwaukee Sentinel,
"Long ago he (mankind) recognized that all perceptible matter comes from a primary substance, of a tenuity beyond conception and filling all space - the Akasha or luminiferous ether - which is acted upon by the life-giving Prana or creative force, calling into existence, in never ending cycles, all things and phenomena. The primary substance, thrown into infinitesimal whirls of prodigious velocity, becomes gross matter; the force subsiding, the motion ceases and matter disappears, reverting to the primary substance".
http://www.rastko.rs/istorija/tesla/oniell-tesla.html
http://www.ascension-research.org/tesla.html

[8] Maxwell, J.C., ***"Ether"*** Encyclopaedia Britannica, Ninth Edition 8: 568-572 (1878) https://en.wikisource.org/wiki/Encyclop%C3%A6dia_Britannica,_Ninth_Edition/Ether_(2.)