The Telegraphy Equation

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Abstract. It is suggested that the telegraphy equations as derived by Kirchhoff and Heaviside have overlooked the distinction between linear polarization and magnetization, and hence mixed two different physical effects into one.

The Electromagnetic Wave Equation

I. The electromagnetic wave equation,

$$\nabla(\nabla.\mathbf{A}) - \nabla^2\mathbf{A} = -\mu\varepsilon\partial^2\mathbf{A}/\partial t^2 \qquad \textbf{(1)}$$

depends on the fact that the divergence of **A** will be zero ($\nabla.\mathbf{A} = 0$). This means that it is describing some kind of solenoidal effect. It is not describing the propagation of a pulse of aether pressure (or a voltage) which would involve variations in the aether density. The sinusoidal and the solenoidal nature of the equation, in conjunction with the fact that we already know that $\partial\mathbf{A}/\partial t$ represents an angular acceleration, provide us with clues as to the nature of electromagnetic radiation. Equation **(1)** points to a propagation of angular acceleration in a sea of tiny aether vortices. Angular acceleration will require a torque whose source is not specified by the electromagnetic wave equation at **(1)**. There may well be propagated pulses of aether pressure involved in the torque mechanism. See section **III** of 'Cathode Rays, Gravity, and Electromagnetic Radiation' at,

http://www.wbabin.net/science/tombe53.pdf

Radiation Pressure

II. Light exerts a force on a physical target. Maxwell calculated the force associated with radiation pressure to be,

$$F = (1/c)dE/dt = dp/dt \quad \textbf{(2)}$$

where E is energy, c is the speed of light, and p is momentum. See page 42 (page 8 of the pdf file) of Dr. Carl A. Zapffe's book 'A Reminder on $E=mc^2$, ---' at,

http://www.wbabin.net/science/rickerzap.pdf

By substituting p = mc into equation (**2**), where m equals mass, we obtain the relationship,

$$c^2dm = dE \quad \textbf{(3)}$$

which implies that an electromagnetic wave has got an associated mass which is related to its energy in the ratio of,

$$E = mc^2 \quad \textbf{(4)}$$

That associated mass suggests a net transfer of aether in the torque mechanism which causes the vortices to angularly accelerate.

Capacitance and Voltage

III. In Maxwell's papers there is no overt mention of the quantity electric charge. The quantities which correspond most closely to charge are either 'density of free electricity' or displacement in an elastic medium.

But with charge nowadays being treated as a quantity that is strictly associated with particles, the meaning tends more to that of being an 'amount' rather than that of being a pressure or a tension.

Hence the modern equivalent of Maxwell's displacement equation (105) in his 1861 paper 'On Physical Lines of Force' [1] is,

$$Q = CV \qquad \textbf{(5)}$$

where Q is charge, C is capacitance, and V is voltage. The shift in emphasis from Maxwell's original equation means that we are more concerned with the amount of charge that is stored in a particular region, or the capacity of that region, when a particular voltage is applied. Maxwell was more focused on the transverse elasticity and the associated stress of electric displacement in a dielectric material when an electromotive force was applied.

We can obtain an electric current from equation **(5)** by differentiating both sides with respect to time,

$$I = C dV/dt \qquad \textbf{(6)}$$

Standard textbooks demonstrate how combining equation **(6)** with Faraday's law of electromagnetic induction leads to Heaviside's telegraphy equation for voltage,

$$\nabla^2 V = -\mu\varepsilon \partial^2 V/\partial t^2 \qquad \textbf{(7)}$$

Equation **(7)** would imply the existence of a pulse of aether pressure propagating at the speed of light.

However, the current in question at equation **(6)** will be associated with linear polarization. It cannot therefore be combined with Faraday's law of electromagnetic induction because linear polarization and magnetization are two different kinds of disturbance.

Conclusion

IV. Maxwell's electromagnetic wave equation only applies to wireless telegraphy and cannot be applied to cable telegraphy. It is an equation for a vortex flow of pressurized aether as opposed to being an equation for the propagation of a pulse of pressurized aether. The electromagnetic wave equation is therefore an electric current equation and not a voltage equation. It is a fine-grained rotational kinetic energy equation and not a potential energy equation. Heaviside and Kirchhoff didn't make the necessary distinction between linear polarization and magnetization when they derived their respective telegraphy equations.

This has implications for electronic engineers who have been trying to apply the electromagnetic wave equation to transmission lines. They have been working with the wrong equation.

References

[1] Clerk-Maxwell, J., "On Physical Lines of Force", Philosophical Magazine, Volume
21, (1861)
http://vacuum-physics.com/Maxwell/maxwell_oplf.pdf