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Event

The genius of James Clerk Maxwell, the man who made equations speak

Date+Time

Friday, 1 December 2017 from 18:30 to 20:30 (GMT)

Location

Italian Cultural Institute
39 Belgrave Square
SW1X 8NX London
United Kingdom

Payment Status

Free Order

Order Info

Order no. 699022609. Ordered by Ivor Catt on 16 November 2017 18:04

Type

The genius of James Clerk Maxwell, the man who made equations speak

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Reply to Mr. Ivor Catt

Dear Mr. Catt,

you contacted me on 17 November 2017 after seeing the announcement of my presentation about "The genius of James Clerk Maxwell: the man who made equations speak" at the Italian Cultural Institute (ICI) in London on 1 December 2017. You asked me to read two papers of yours (from now on referred to as paper 1 and paper 2) and give my opinion about their content. Since then you have sent me a large number of email messages and, against my request, added my name as cc in many other email messages of yours to many people, including distinguished scientists and academics and containing some of your opinions that I do not support or agree about at all.

After your courteous appearance at my presentation in London on 1 December 2017, I told you that I was willing to read and comment on papers 1 and 2. The following pages address the content of papers 1 and 2 to fulfil my promise. I have to be frank, you will see that 1) I disagree on all of your statements about Maxwell's equations; 2) I provide mathematical and physical evidence of the correctness of Maxwell's equation; 3) I provide mathematical and physical evidence of the fallacy of your arguments. Please note that all my statements are entirely related to the content of papers 1 and 2 and under no circumstances are a comment on your right to put your views forward.

In view of the completion of my duties and of the difference of our opinions about Maxwell's equations, I would appreciate if you would refrain from including my email address in any of your future communications. As mentioned in one of my email messages, failure to do so will result in my University requesting a legal injunction to protect my email account from receiving unwanted spam email messages or from including my email address in messages where the content is in open contradiction with my professional views and opinions.

Best regards,

prof. gian-luca oppo

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On the Correctness, Relevance and Importance of Maxwell's Equations

In [1], Mr. I. Catt claims that "the mathematical formulation of the e-m theory (i.e. Maxwell's equations), far from making the subject more rigorous, has made it ludicrous and false". In [2], Catt claims that Maxwell's equations for an electro-magnetic wave in vacuum are 'Catt's equations for two thick short planks and contain virtually no information about the nature of electromagnetism'. Mr. Catt starts from the following equation:

$$\frac{\partial h}{\partial x}\frac{dx}{dt} = \frac{\partial h}{\partial t} \qquad (1)$$

written for a 'high speed train' with a descending nose where $h(x,t)$ is the vertical coordinate of the sloping nose of the train, x is its horizontal coordinate and t is the time. It is easy to see from differential calculus that Eq. (1) is nothing else than

$$\frac{\partial h}{\partial t} = \frac{\partial h}{\partial t} \qquad (2)$$

i.e. it has the physical content of anything being equal to itself such as 1=1 or $\pi = \pi$.

In [1] and [2] there is a reference to Maxwell's third and fourth equations written for an electromagnetic wave propagating in free space along the x-direction (with the electric field pointing in the y-direction and the magnetic field in the z-direction, see Fig. 1). Maxwell's equations for this case are:

$$\frac{\partial E_y}{\partial x} = -\frac{\partial B_z}{\partial t} \qquad -\frac{\partial B_z}{\partial x} = \mu_0 \varepsilon_0 \frac{\partial E_y}{\partial t} \qquad (3)$$

where E_z is the component of the electric field in the z-direction, B_y is the component of the magnetic field in the y-direction, μ_0 is the magnetic permeability of free space, ε_0 is the electric permittivity of free space.

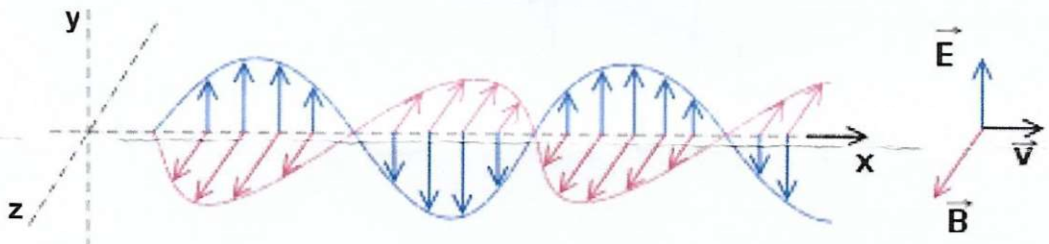

Figure 1. A transverse electromagnetic wave propagating along the direction x at a generic time t in agreement with Maxwell's equations.

These are equivalent to those quoted by Mr. Catt in both [1] and [2]:

$$\frac{\partial E_y}{\partial x} = -\frac{\partial B_z}{\partial t} \qquad \frac{\partial H_z}{\partial x} = -\frac{\partial D_y}{\partial t} \qquad (4)$$

By considering the simplest form of a travelling wave, one can easily find that

$$E_y = E_0\sin(kx - \omega t) \qquad \frac{\partial E_y}{\partial x} = k\, E_0\cos(kx - \omega t) \qquad (5)$$

$$B_z = B_0 \sin(kx - \omega t) \qquad \frac{\partial B_z}{\partial t} = -\omega\, B_0 \cos(kx - \omega t) \qquad (6)$$

Replacing these in the first equation of (3) or (4), one finds

$$\frac{E_0}{B_0} = \frac{\omega}{k} = \lambda f = c \qquad (7)$$

From the second equation of (3) or (4) one gets:

$$-\frac{\partial B_z}{\partial x} = -k\, B_0 \cos(kx - \omega t) = \mu_0\varepsilon_0 \frac{\partial E_y}{\partial t} = -\mu_0\varepsilon_0\omega\, E_0\cos(kx - \omega t)$$

$$\frac{E_0}{B_0}\frac{\omega}{k} = c^2 = \frac{1}{\mu_0\varepsilon_0} \; . \qquad (8)$$

Eq. (1) by Catt cannot be compared with either the third or the fourth of Maxwell's equations (3) since in Eq. (1) the same quantity appears on both sides of the equation while in Maxwell's equations we have the electric field on one side and the magnetic field on the other.

In papers [1] and [2] Catt suggests the equations for a moving plank of wood with a pointy end. Here the height h and width w are related by $h/w = z$. Since h and w have the units of lengths, z is a pure number. For these quantities, Catt writes:

$$\frac{\partial h}{\partial x} = -\frac{z}{v}\frac{\partial w}{\partial t} \qquad \frac{\partial w}{\partial x} = -\frac{1}{zv}\frac{\partial h}{\partial t} \qquad (9)$$

where v is the velocity of the plank. Catt then incorrectly postulates that the temperature T of a plank of wood at thermodynamic equilibrium with the surrounding (i.e. same temperature in the entire plank) is proportional to the density ρ of the plank and talks about spontaneous combustion. Catt's Equations (5) and (6) in [2] have no physical meaning and should be discarded.

We now compare Equations (9) (Catt's equations for a moving plank of wood) with Equations (3) using the result (8), i.e.

$$\frac{\partial E_y}{\partial x} = -\frac{\partial B_z}{\partial t} \qquad \frac{\partial B_z}{\partial x} = -\frac{1}{c^2}\frac{\partial E_y}{\partial t} \qquad (10)$$

In [2] Catt claims that Equations (9) and (10) are the same and that since (9) contains 'no information about the nature of electromagnetism', neither do Maxwell's Equations (10). First, Equations (9) are written for two lengths (height and width) of a plank of wood while the variables of (10) are the electric and magnetic field components. These cannot be more different. Second, in Equations (10) the velocity of the e.m. wave c appears quadratically in the second equation and not as trivially as the velocity v in Equations (9) where it mainly transforms the derivative with respect to space into the derivative with respect to time. Third, Equations (7 & 8) predict that the speed of an e.m. wave in free space is $c = 1/\sqrt{\mu_0 \varepsilon_0}$ a fact that has been demonstrated experimentally thousands of times since Maxwell's discovery and is intrinsic to the nature of electromagnetism. They also predict that the the electric and magnetic field vectors of an e.m. wave in free space are perpendicular to each other and hold a fixed amplitude ratio given by Equation (7). Again, these are facts intrinsic to the nature of electromagnetism and have no relation to the physics of a moving plank of wood. Equations (9) do not predict anything, they just describe mathematically what happens to a moving plank of wood with width proportional its height.

We can conclude that papers [1] and [2] incorrectly attempt, and then fail, to establish a physical and mathematical equivalence between the equations of a moving plank of wood and the third and fourth of Maxwell's equations for an electromagnetic wave in free space. By failing to do this, Catt's papers [1] and [2] actually demonstrate how revolutionary, correct, in agreement with experiments and revealing of the intrinsic nature of electromagnetism, Maxwell's equations are. They are one of the most outstanding successes of human endeavour in the understanding of the physical reality. As Albert Einstein said: *Since Maxwell's time, Physical Reality has been thought of as represented by continuous fields, governed by partial differential equations, and not capable of any mechanical interpretation. This change in the conception of Reality is the most profound and the most fruitful that physics has experienced since the time of Newton.* Fact. The two main claims made by Mr. Catt in papers [1] and [2] (that "the mathematical formulation of the e-m theory (i.e. Maxwell's equations), far from making the subject more rigorous, has made it ludicrous and false" and that Maxwell's equations for an electro-magnetic wave in vacuum are "Catt's equations for two thick short planks and contain virtually no information about the nature of electromagnetism") are then proven unfounded. There is no 'Catt's anomaly', just scientifically poor mathematical and physical statements.

To conclude, we note the limitation of Catt's considerations about a moving plank of wood. With height and width increasing linearly, the considerations can only be applied to a relatively small length of the plank. Let me consider the following solution of Catt's Equations (9)

$$h = h_0 \sin(kx - \omega t) \qquad \frac{\partial h}{\partial x} = k\, h_0 \cos(kx - \omega t)$$

$$w = w_0 \sin(kx - \omega t) \qquad \frac{\partial w}{\partial t} = -\omega\, w_0 \cos(kx - \omega t) \qquad (11)$$

$$k h_0 = \omega \frac{z}{v} w_0 \qquad v = \frac{\omega}{k} = \lambda f$$

i.e. Catt's Equations (9) are satisfied by travelling wave solutions. This is no surprise since $\sin(x) \sim x$ for small x and Equations (9) have been obtained in the linear case. At difference from Maxwell's equations where each equation provides an important physical insight, the two Equations (9) are a just a repetition of each other. Two examples of periodic wave-like solutions of a moving plank of wood are provided in Figures 2 and 3 for $z = 1$. The solution displayed in Fig. 3 corresponds to one possible sinusoidal solution of the kind of Equations (11). These solutions can be extended to suitably shaped wood planks of arbitrary length.

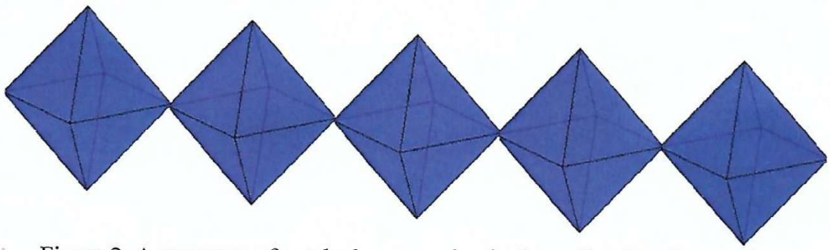

Figure 2. A sequence of octahedrons moving in the x-direction that can be a solution of Equations (9) for $z = 1$.

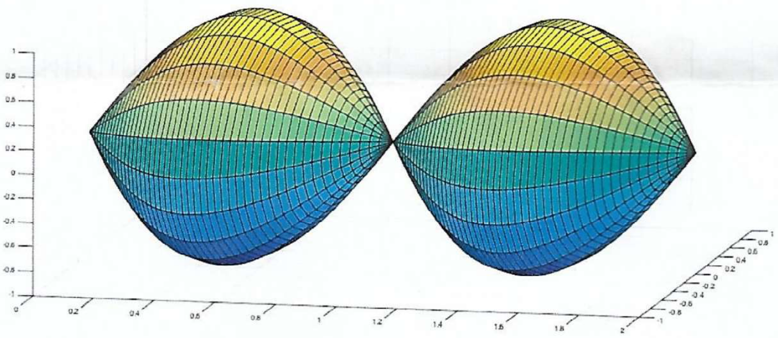

Figure 3. A periodic sinusoidal solution of the kind (11) moving along the x-direction of Equations (9) with $z = 1$.

This shows that mathematical equations applied to physical set-up can provide useful insights about the specifics of the physical configurations. Travelling wave solutions and their corresponding dynamical equations have been found and used in a plethora of physical examples from sound propagation to water waves, from earthquakes to light, from the motion of a guitar string to moving planks of woods. The fact that the mathematical formulae of a travelling wave are generic does not mean that the physical phenomena that they describe are the same as, or equivalent to, each other. This is known as 'universality' of theoretical approaches in dynamics. Light propagating in a nonlinear optical fibre and Bose-Einstein condensates are described by Nonlinear Schroedinger Equations and Gross-Pitaevskii Equations, respectively, that turn out to have the same exact mathematical form. No one would say that the two experimental set-ups are the same but the universality means that some peculiar solutions of these equations, such as solitons, can be equally applied to both configurations with great insight and success in both photonics and atomic physics.

Papers [1] and [2] are fallacious not only in mathematical and physical terms (see above) but also in philosophical terms when using the universality of theoretical approaches to oscillations and waves to invalidate Maxwell's theories instead of strengthen them.

References:

[1] I. Catt, "Maxwell's equations revisited", Wireless World, March 1980, page 77.

[2] I. Catt, "The hidden message in Maxwell's equations", Electronic and Wireless World, November 1985, page 184.