Professor Gian-Luca Oppo -ats- Mr. Ivor Catt

Stephen J. Crothers[1]
(Australia)
thenarmis@yahoo.com

27th January 2018

Preamble

Mr. Ivor Catt is a retired electrical engineer who, amongst other things electrical, worked for decades in industry as a pioneer in the development of digital electronic hardware and digital electronic hardware design, with sometime patents for his inventions in digital electronic hardware (e.g. Catt Spiral), and books on the subject to his credit. Professor Gian-Luca Oppo is a professor of theoretical physics (Computational and Nonlinear Physics) at the public University of Strathclyde, Scotland, who, as far as can be ascertained from his public academic webpage at the University of Strathclyde, has no experience in electrical engineering in industry or otherwise. According to his University public profile, "*Oppo is author of more than 140 publications in peer-review journals and books.*" It appears, again from his University profile, that professor Oppo's scientific experience has only ever been in academia, and then only as a theoretician.

Mr. Catt has been a critic of Maxwell's theory of electromagnetism owing to his practical experience in industry, particularly digital electronics hardware. Professor Oppo is a defender of Maxwell's theory of electromagnetism.

Professor Oppo recently delivered a lecture in London on Maxwell's theory of electromagnetism (*James Clerk Maxwell, the man who made equations speak, Italian Cultural Institute, 39 Belgrave Square, London, 1st December, 2017*). Mr. Catt attended his lecture. They met after the lecture. Mr. Catt requested professor Oppo to comment on two of the former's papers [1,2]. Professor Oppo subsequently made his comments in writing [3].

Professor Oppo has threatened Mr. Catt with legal action for including the professor's publicly available taxpayer funded University of Strathclyde email address in a group mailing on this important scientific matter. Mr. Catt has taken the view that science is not a secretive affair; such secrets being left to Masonic and such secret societies.

I comment following on professor Oppo's criticisms of Mr. Catt's two papers.

(1) Mr. Catt's eq.(1) in [1] is:

$$\frac{\partial h}{\partial x}\frac{dx}{dt}=\frac{\partial h}{\partial t} \quad . \tag{1}$$

Professor Oppo takes exception to Mr. Catt writing this expression on the following grounds:

"*... 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*

1 Anybody can email me and include others without threat of legal action for doing so.

differential calculus that Eq. (1) is nothing else than

$$\frac{\partial h}{\partial t}=\frac{\partial h}{\partial t} \tag{2}$$

i.e. it has the physical content of anything being equal to itself such as 1=1 or π=π."

However, there is certainly nothing wrong with Mr. Catt's eq.(1). Professor Oppo has not realised that eq.(1) is in fact an expression for a progressive wave having the speed of propagation dx/dt. If the speed $dx/dt = v$ constant, and the wave travels in the negative x-direction, then its equation is:

$$\frac{\partial h}{\partial x}v=\frac{\partial h}{\partial t} \quad . \tag{1b}$$

If the speed $dx/dt = v$ constant, and the wave travels in the positive x-direction, then its equation is:

$$\frac{\partial h}{\partial x}v=-\frac{\partial h}{\partial t} \quad . \tag{1c}$$

This is easily seen by recalling the fact that the waveform $h = h(x,t)$ may vary from place to place at any given instant and may also vary with time at any given place. The positive sign in eq.(1b) and the negative sign in eq.(1c) are readily understood by the fact that,

$$h(x,t)=h(x-vt) \tag{1d}$$

for a wave travelling in the positive x-direction with constant speed v, and that,

$$h(x,t)=h(x+vt) \tag{1e}$$

for a wave travelling in the negative x-direction with constant speed v. The foregoing is easily demonstrated mathematically. The total differential of $h(x,t)$ is:

$$dh=\frac{\partial h}{\partial x}dx+\frac{\partial h}{\partial t}dt \quad .$$

The total derivative of $h(x,t)$ with respect to t is then,

$$\frac{dh}{dt}=\frac{\partial h}{\partial x}\frac{dx}{dt}+\frac{\partial h}{\partial t} \quad . \tag{1f}$$

Fixing attention to a particular value of h implies that $dh/dt = 0$. Hence, eq.(1f) reduces to,

$$\frac{\partial h}{\partial x}\frac{dx}{dt}=-\frac{\partial h}{\partial t} \quad . \tag{1g}$$

If $dx/dt = v$ is positive, eq.(1g) is the equation for a wave travelling in the positive x-direction:

$$\frac{\partial h}{\partial x}v=-\frac{\partial h}{\partial t} \quad .$$

If $dx/dt = -v$, then the wave travels in the negative x-direction and eq.(1g) becomes,

$$\frac{\partial h}{\partial x}v=\frac{\partial h}{\partial t} \quad .$$

The forms (1b) through to (1e) satisfy the general wave equation for propagation in either the positive or negative x-direction:

$$\frac{\partial^2 h}{\partial x^2}=\frac{1}{v^2}\frac{\partial^2 h}{\partial t^2} \quad .$$

Now consider Mr. Catt's eq.(2) in [1]:

$$\frac{\partial H}{\partial x}\frac{dx}{dt}=\frac{-\partial H}{\partial t} \quad .$$

Applying to this equation professor Oppo's argument on Mr. Catt's eq.(1), it must be that:

$$\frac{\partial H}{\partial t}=\frac{-\partial H}{\partial t} \quad ,$$

which can only hold if H is a constant or is not a function of t.

(2) Recall that in Maxwell's equations,

$$\vec{D}=\varepsilon\vec{E} \quad , \quad \vec{B}=\mu\vec{H} \quad \text{and} \quad c=\frac{1}{\sqrt{\mu\varepsilon}} \quad . \tag{2}$$

Professor Oppo [3] writes "*Maxwell's third and fourth equations ... 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 pointing in the z-direction)*" are:

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

whereas Mr. Catt's equivalent eqs.(3) and (4) are, using (2) and dispensing with subscripts:

$$\frac{\partial E}{\partial x}=\frac{-\partial B}{\partial t} \tag{3-Catt}$$

$$\frac{\partial H}{\partial x}=\frac{-\partial D}{\partial t} \tag{4-Catt}$$

Professor Oppo ignored Mr. Catt's eq.(2) in [1] for an electromagnetic wave, which is:

$$\frac{\partial H}{\partial x}\frac{dx}{dt}=\frac{-\partial H}{\partial t} \quad , \tag{2-Catt}$$

and instead of referring to it referred to Mr. Catt's eq.(1) in **§1** above, complaining that [3]:

"Eq.(1) by Catt cannot be compared with either the third or 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."

Professor Oppo's complaint has no valid basis in any event of Mr. Catt's eq.(1) or eq.(2-Catt). The professor appears to be unaware that the first of his eqs.(3) above can be written in the form of eq. (2-Catt) so that the same quantity, the magnetic field *H*, appears on both sides of the equation, contrary to his complaint. To see this note Mr. Catt's un-numbered equation between his eqs. (2) and (3) in his paper [1]. It is:

$$\frac{E}{H}=\sqrt{\frac{\mu}{\varepsilon}} \quad . \tag{Catt unnumbered}$$

Now multiplying through by $1/\mu$ and using relations (2) above gives:

$$\frac{E}{\mu H}=\frac{E}{B}=\frac{1}{\sqrt{\mu\varepsilon}}=c \quad ,$$

which is professor Oppo's eq.(7). Using relations (2), equation (Catt unnumbered), and dispensing with subscripts, the first of professor Oppo's eqs.(3) above becomes,

$$\frac{\partial E}{\partial x}=-\mu\frac{\partial H}{\partial t} \quad ,$$

so

$$\frac{\partial E}{\partial x}\frac{1}{\mu}=\frac{-\partial H}{\partial t} \quad ,$$

or

$$\frac{\partial E}{\partial x}\sqrt{\frac{\varepsilon}{\mu}}\frac{1}{\sqrt{\mu\varepsilon}}=\frac{-\partial H}{\partial t} \quad . \tag{4}$$

Now

$$\frac{dx}{dt}=\frac{1}{\sqrt{\mu\varepsilon}}=c \quad \text{and} \quad \frac{\partial E}{\partial x}\sqrt{\frac{\varepsilon}{\mu}}=\frac{\partial H}{\partial x} \quad .$$

Putting these into eq.(4) yields,

$$\frac{\partial H}{\partial x}\frac{dx}{dt}=\frac{-\partial H}{\partial t} \quad , \tag{5}$$

which is precisely Mr. Catt's eq.(2) in [1] (eq. 2-Catt above). The magnetic field H is now on both sides of the equation, contrary to professor Oppo's complaint. Professor Oppo's third Maxwell equation is really the same as eq.(5) above, hence the very same as Mr. Catt's eq.(2-Catt) above. The professor's objection is without merit.

Moreover, if the electromagnetic wave travels in the negative x-direction, then $dx/dt = -c$ and eq.(5) becomes:

$$\frac{\partial H}{\partial x}c = \frac{\partial H}{\partial t} \quad . \tag{5b}$$

Compare this with Mr. Catt's eq.(1) for propagation in the negative x-direction with speed dx/dt:

$$\frac{\partial h}{\partial x}\frac{dx}{dt} = \frac{\partial h}{\partial t} \quad .$$

Thus, contrary to professor Oppo's complaint, the third and fourth Maxwell equations can in fact be compared with Mr. Catt's eq.(1).

In a similar fashion, the second of professor Oppo's eqs.(3) above for Maxwell can be written as:

$$\frac{\partial E}{\partial x}\frac{dx}{dt} = \frac{-\partial E}{\partial t} \quad , \tag{5c}$$

in which case the electric field is now on both sides of the equation. For propagation in the negative x-direction at speed c, $dx/dt = -c$ and eq.(5c) becomes:

$$\frac{\partial E}{\partial x}c = \frac{\partial E}{\partial t} \quad . \tag{5d}$$

Mr. Catt [1] has correctly pointed out that eq.(5) above (and hence, also eq.(5c)),

"never appears in the text books. In the books, one of the terms is first converted to the formula

$$\frac{E}{H} = \sqrt{\frac{\mu}{\varepsilon}} \quad .$$

The result is either

$$\frac{\partial E}{\partial x} = \frac{-\partial B}{\partial t} \tag{3}$$

or

$$\frac{\partial H}{\partial x} = \frac{-\partial D}{\partial t} \tag{4}$$

(4)."

Mr. Catt is correct, as the derivations above of eqs.(5) and (5c) above from professor Oppo's Maxwell equations (3) attests.

(3) In his paper [2], Mr. Catt writes with tongue in cheek of the differential equations for one and two short wooden planks moving with speed v in the positive x-direction. Professor Oppo writes:

"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/x = 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."

First, Mr. Catt did not invoke thermodynamic equilibrium. This is an embellishment introduced by professor Oppo. Second, Mr. Catt's wooden plank equations do indeed have no physical meaning; which is his very point. Since the equations for one or two short planks have the very same form as Maxwell's equations they bear the very same supposed cause-effect relations as Maxwell's equations. Mr. Catt argues that Maxwell's equations therefore also have little or no physical meaning. This is reiterated in Mr. Catt's equations relating temperature T and density ρ for short wooden planks in the same mathematical form of Maxwell's equations for an electromagnetic wave, *to wit*:

$$\frac{\partial T}{\partial x} = -\frac{z}{v}\frac{\partial \rho}{\partial t}$$

$$\frac{\partial \rho}{\partial x} = -\frac{1}{zv}\frac{\partial T}{\partial t}$$

$$z = \frac{T}{\rho}$$

The jest is explicit in Mr. Catt's [2] reference to "*spontaneous combustion*" and his remark that "*These equations remain valid for two thick short planks moving forward side by side*". Professor Oppo is an Italian. Perhaps this is why he does not seem to understand what, in common parlance, a native English speaker means when he refers to a fellow being as thick as two short planks. The quantities T and ρ in the equations above are not orthogonal to one another or to the x-axis, are not the cause and effect of one another, and do not propagate as waves in the positive x-direction with speed v, their satisfaction of the general wave equation notwithstanding. There are no temperature waves and no density waves of wooden planks, just as there are no propagating waves of the height and width of wooden planks. It clearly does not follow from the mathematical form that there must be cause and effect present, as Mr. Catt has argued in relation to Maxwell's equations.

Professor Oppo [3] goes on with complaining:

"We now compare Equations (9) (Catt's equation 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."

Professor Oppo is incorrect; completing missing the point. Mr. Catt's equations for moving thick short wooden planks say virtually nothing about the nature of wooden planks. The wooden plank equations have the very same form as Maxwell's equations and the height *h* and width *w* of the planks bear the same supposed cause-effect relations as *H* and *E* alleged in Maxwell's equations. Consequently, Maxwell's equations say as little about electromagnetism as the wooden plank equations say about moving wooden planks. In his paper [2] Catt remarks:

"Returning to equation 1, this is only valid if the constant in the equation equals the velocity of propagation v. When we mix together h and w to produce the hybrid equations 2 and 4, they only remain true if h and w are in fixed proportion z. So we find that Maxwell's Equations 9 and 10 are only true if at every point in space E is proportional to H, and also if the velocity of electromagnetism has the fixed value c. So the only information about electromagnetism contained in the apparently sophisticated equations 9 and 10 is about the two ruling constants in electromagnetism: the fixed velocity c, and that E, H at every point are in fixed proportion Z_o*. The remaining content of Maxwell's equations is hogwash."*

The height and width on the one hand and the electric and magnetic fields on the other makes no difference to the arguments. Here again arises the problem of understanding the meaning of a fellow being as thick as two short planks.

Professor Oppo [3] complains further:

"Second, in Equations (10) the velocity of the e.m. wave c appears quadratically in the second equation and not 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."

This complaint furthers his complaint [3] that $z = h/w$ is a pure number, so that zv is not speed squared, whereas in the professor's eqs.(10) the speed squared (i.e. c^2) appears in place of zv in eqs. (9). Professor Oppo's objection carries no weight. Consider the second of the professor's eqs.(10):

$$\frac{\partial B_z}{\partial x}=\frac{-1}{c^2}\frac{\partial E_y}{\partial t} \quad . \qquad (6)$$

Now,

$$c=\frac{1}{\sqrt{\mu\varepsilon}}, \quad B_z=\mu H_z \quad \text{and} \quad \frac{E_y}{H_z}=\sqrt{\frac{\mu}{\varepsilon}} \quad ,$$

so,

$$\mu=\sqrt{\mu\varepsilon}\sqrt{\frac{\mu}{\varepsilon}}=\frac{1}{c}\frac{E_y}{H_z} \quad .$$

Setting Z= E_y/H_z, eq.(6) can be written equivalently as:

$$\frac{\partial H_z}{\partial x}=\frac{-1}{cZ}\frac{\partial E_y}{\partial t} \quad . \tag{7}$$

Compare this with Mr. Catt's equation for moving short planks:

$$\frac{\partial w}{\partial x}=\frac{-1}{vz}\frac{\partial h}{\partial t} \quad . \tag{8}$$

Equations (7) and (8) have the same form, although in (7) Z has units whereas in (8) z has no units. However, although the Florentine professor makes much of it, this is a trivial issue, as the general progressive wave equation will soon show.

In similar fashion, the professor's first of his eqs.(10) can be written equivalently as:

$$\frac{\partial E_y}{\partial x}=-\frac{Z}{c}\frac{\partial H_z}{\partial t} \quad . \tag{9}$$

Compare this with Mr. Catt's equation for moving short planks:

$$\frac{\partial h}{\partial x}=-\frac{z}{v}\frac{\partial w}{\partial t} \quad . \tag{10}$$

Tabulate now the equations, for easy comparison:

Catt	**Oppo (for Maxwell)**
$z=\frac{h}{w}$	$Z=\frac{E}{H}$
$\frac{\partial h}{\partial x}=-\frac{z}{v}\frac{\partial w}{\partial t}$, $\frac{\partial w}{\partial x}=-\frac{1}{vz}\frac{\partial h}{\partial t}$	$\frac{\partial E_y}{\partial x}=-\frac{Z}{c}\frac{\partial H_z}{\partial t}$, $\frac{\partial H_z}{\partial x}=\frac{-1}{cZ}\frac{\partial E_y}{\partial t}$
$\frac{\partial^2 h}{\partial x^2}=-\frac{z}{v}\frac{\partial^2 w}{\partial x \partial t}$, $\frac{\partial^2 w}{\partial t \partial x}=-\frac{1}{vz}\frac{\partial^2 h}{\partial t^2}$	$\frac{\partial^2 E_y}{\partial x^2}=-\frac{Z}{c}\frac{\partial^2 H_z}{\partial x \partial t}$, $\frac{\partial^2 H_z}{\partial t \partial x}=-\frac{1}{cZ}\frac{\partial^2 E_y}{\partial t^2}$
$\frac{\partial^2 w}{\partial x^2}=-\frac{1}{vz}\frac{\partial^2 h}{\partial x \partial t}$, $\frac{\partial^2 h}{\partial t \partial x}=-\frac{z}{v}\frac{\partial^2 w}{\partial t^2}$	$\frac{\partial^2 H_z}{\partial x^2}=-\frac{1}{cZ}\frac{\partial^2 E_y}{\partial x \partial t}$, $\frac{\partial^2 E_y}{\partial t \partial x}=-\frac{Z}{c}\frac{\partial^2 H_z}{\partial t^2}$
$\frac{\partial^2 h}{\partial x^2}=\frac{1}{v^2}\frac{\partial^2 h}{\partial t^2}$, $\frac{\partial^2 w}{\partial x^2}=\frac{1}{v^2}\frac{\partial^2 w}{\partial t^2}$	$\frac{\partial^2 E_y}{\partial x^2}=\frac{1}{c^2}\frac{\partial^2 E_y}{\partial^2 t}$, $\frac{\partial^2 H_z}{\partial x^2}=\frac{1}{c^2}\frac{\partial^2 H_z}{\partial t^2}$

Note the final row of equations. They are each the general wave equation for a progressive wave in one direction. On the left the height h and the width w of the short planks are propagated as waves with speed v in either the positive or negative x-direction. On the right the electric field E and the magnetic field H are propagated as waves with speed c in either the positive or negative x-direction. Does the form of the equations mandate that height h of the moving wooden planks causes the width w and the width w causes the height h? Can h and w be both causes and effects of one another in phase simultaneously? In like fashion, does the form of the equations mandate that electric field E of the electromagnetic wave cause the magnetic field H and magnetic field H cause the electric field E? Can E and H be both causes and effects of one another in phase simultaneously? Professor Oppo chose silentio on these questions. In the appendix of [2] Mr. Catt states:

"The cross-linkage of electric and magnetic fields E and H in Maxwell's Equations only obscure the issue. There is no interaction between E and H. (Similarly, the width of a brick does not interact with its length.) They are coexistent, co-substantial, co-eternal."

Mr. Catt argues that since the equations for the moving wooden planks are the same form as those for the electromagnetic wave, then any causal relations between the terms in the equations must be the same respectively. He points out that since the equations for the moving short planks say little about the nature of wooden planks, and bear no causal relations between height h and width w thereof, Maxwell's equations say little about the nature of electromagnetism and bear no causal relations between the electric field E and the magnetic field H thereof.

(4) Professor Oppo complains that his,

"Equations (7 & 8) predict the speed of an e.m. wave in free space is $c = 1/\sqrt{\mu_0 \varepsilon_0}$ *... also predict that 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."*, whereas Mr. Catt's equations for moving wooden planks *"do not predict anything"*.

First, Mr. Catt does not dispute that electromagnetic waves travel at the speed of light c, that they have a fixed amplitude ratio, and that E and H are orthogonal to one another. In [2] Mr. Catt states:

"In general, Maxwell's Equations tell us only the obvious truisms about any body or material moving through space. It is the obscurantism of the fancy maths in which they are dressed that has for the last century caused scholars to think that they contain significant information about the nature of electromagnetism. ... So we find that Maxwell's Equations 9 and 10 are only true if at every point in space E is proportional to H, and also if the velocity of electromagnetism has the fixed value c. So the only information about electromagnetism contained in the apparently sophisticated equations 9 and 10 is about the two ruling constants in electromagnetism: the fixed velocity c, and that E, H at every point are in fixed proportion Z_0*."*

Second, the height and width of Mr. Catt's moving wooden plank are perpendicular to one another and hold a fixed amplitude ratio. These are facts intrinsic to the nature of moving wooden planks.

Third, professor Oppo has again misunderstood '*thick as two short planks*'.

Fourth, the real significance of $c = 1/\sqrt{\mu_0 \varepsilon_0}$ appearing in Maxwell's equations is that since electromagnetic waves travel at the speed of light, light must be an electromagnetic wave, not a wooden plank wave.

(5) Professor Oppo [3] complains that Mr. Catt's equations for wooden planks are:

"At difference from Maxwell's equations where each equation provides an important physical insight, the Equations (9) are just a repetition of each other."

With reference to the table of equations in **§3** above, it is obvious that if Mr. Catt's equations for wooden planks are repetitions of each other, then so are Maxwell's Equations presented by the professor at his eqs.(3) and (10), since they have the very same mathematical form. As to the important physical insights from each of Maxwell's equations, the professor does not say.

(6) In his concluding sections professor Oppo [3] says:

"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."

First, the full statements made by Mr. Catt in [2] that Professor Oppo [3] quoted above in part are:

"By algebra, we find that $\mu_0 = Z_0/c$ *and* $\epsilon_0 = 1/cZ_0$ *(ref.10). We can now see that equations 9 and 10 are in fact 5 and 6, Catt's equations for two thick short planks, and contain virtually no information about the nature of electromagnetism."*

Mr. Catt argues that since his equations for two short planks contain virtually no information about wooden planks, and have the very same form as the Maxwell's equations, the corresponding Maxwell equations contain virtually no information about electromagnetism.

Professor Oppo's last remark in the passage above reveals that he obviously does not know what 'Catt's Anomaly' is. This is a problem common to critics of Mr. Catt, especially Florentine professors[2] [4-7].

"The Catt Anomaly concerns the refusal of certain named academic experts in Classical Electromagnetic Theory (M. Pepper, N. McEwan, B. Josephson, P. Secker, J. Mink,), who have given different answers to The Catt Question, to talk to one another about their different answers to The Catt Question, bearing in mind that their different answers cannot all be right, and possibly all are wrong. In the absence of any discussion between themselves, the said experts can never come to any agreement on an answer, right or wrong; hence The Anomaly. These academic experts have since chosen silence instead of discussion. Apparently they all think they are right, despite their different answers to the same question. The Catt Question thus remains an open question for Classical Electromagnetic Theory." [6]

The professor [3] writes:

"The fact that mathematical formulae of a travelling wave are generic does not mean that the

2 Professor Oppo is sometime from Florence, Italy.

physical phenomena that they describe are the same as, or equivalent to, each other."

This comment bears no relation to the price of fish. Whatever goes into the general wave equation involves waving, one way or another. This is manifest in the mathematical relations between the terms of the general wave equation. Notwithstanding satisfaction of the general wave equation, what is waving thereby does not necessarily exist, as Mr. Catt's wooden planks example attests. Moreover, his example also reveals that there is no compulsion for any cause-effect relations between terms, such as height with width and vice-versa, or electric field with magnetic field and vice-versa, owing to mere satisfaction of the wave equation.

Finally, in his concluding commentary the professor enlists the authority of Albert Einstein, thus:

"*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.*"

There is no hiding that Einstein included his own General Theory of Relativity in this "*Physical Reality ... represented by continuous fields*". As a lesson in the perils of argument from Authority, I close with a criticism of Einstein and his followers. Einstein required his General Theory of Relativity to comply with the experimental reality of the usual conservation of energy and momentum for a closed system. To make it so he invented his 'pseudotensor' t_σ^α for the energy-momentum of his 'gravitational field alone', designing it purposely so that when added to his energy-momentum tensor for his material sources he could take an ordinary divergence of the sum and get zero: to profess satisfaction of the usual conservation laws [8]. But his pseudotensor is not a tensor and is co-ordinate dependent. It is therefore inconsistent with Einstein's basic tenet that all the equations of physics must be tensorial to effect co-ordinate independence. Einstein and his followers however assert that his pseudotensor is admissible because it acts 'like a tensor' under linear transformations of co-ordinates. Einstein's pseudotensor is defined [8] by:

$$t_\sigma^\alpha = \frac{1}{\kappa}\left(\frac{1}{2}\delta_\sigma^\alpha g^{\mu\nu}\Gamma_{\mu\beta}^\lambda\Gamma_{\nu\lambda}^\beta - g^{\mu\nu}\Gamma_{\mu\beta}^\alpha\Gamma_{\nu\sigma}^\beta\right) .$$

Since it allegedly acts 'like a tensor' it can be contracted 'like a tensor', to produce an invariant t, thus:

$$t = t_\alpha^\alpha = \frac{1}{\kappa}\left(\frac{1}{2}\delta_\alpha^\alpha g^{\mu\nu}\Gamma_{\mu\beta}^\lambda\Gamma_{\nu\lambda}^\beta - g^{\mu\nu}\Gamma_{\mu\beta}^\alpha\Gamma_{\nu\alpha}^\beta\right) .$$

Examination of this result reveals that the invariant t is a first-order intrinsic differential invariant. However, the pure mathematicians proved in 1900 that first-order intrinsic differential invariants do not exist! Thus, by *reductio ad absurdum*, Einstein's pseudotensor, not only having no physical meaning, has no mathematical meaning either. His pseudotensor is a meaningless concoction of mathematical symbols, in violation of the rules of pure mathematics. It is therefore certainly false. Consequently it cannot represent the energy-momentum of his 'gravitational field alone', or anything else. Einstein's followers are as ignorant of this fact, amongst many others, as was Einstein [9]. Yet Einstein and his followers use his pseudotensor to represent alleged physical phenomena and to make calculations. Einstein's objective cannot in fact be achieved. His General Theory of Relativity violates the usual conservation of energy and momentum for a closed system so well established by a vast array of experiments [9]. Any theory that violates the experimental facts is invalid. As with champions of Maxwell, the followers of Einstein however, also ignore all criticism, all facts, all reason, and proceed business as usual. It is no wonder that they are now trying to contact aliens, using radio telescopes all around the world, funded by $100,000,000.00 of Milner's thoughtless money [10,11].

REFERENCES

[1] Catt, I., Maxwell's equations revisited, *Wireless World*, March 1980, p.77, http://www.ivorcatt.co.uk/x18j73.pdf

[2] Catt, I., The hidden message in Maxwell's equations, *Electronics & Wireless World*, November 1985, p. 184, http://www.ivorcatt.co.uk/x18j184.pdf

[3] Oppo, G.-L., Reply to Mr. Ivor Catt : On the Correctness, Relevance and Importance of Maxwell's Equations, http://ivorcatt.co.uk/x811.pdf

[4] Pieraccini, M., & Selleri, S. "Catt's Anomaly", IEEE *Antennas and Propagation Magazine*, Vol. 54, No. 6, December 2012, pp. 240 – 241, http://www.ivorcatt.co.uk/x54c.pdf

[5] Pieraccini, M., and Selleri, An apparent paradox: Catt's anomaly, *Physics Education*, 48 (6), pp. 718-722, IOP Publishing Ltd., 2013

[6] Crothers, S.J., Catt's Anomaly?, IEEE *Antennas and Propagation Magazine*, Volume: 59, Issue: 1, Feb. 2017, http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=7839349

[7] Crothers, S.J., On An Apparent Resolution of The Catt Question, *Progress in Physics*, v.12, Issue 1, pp. 68-69, 2016, http://ptep-online.com/2016/PP-44-13.PDF

[8] Einstein, A., The foundation of the general theory of relativity, *Annalen der Physik*, 49, 1916

[9] Crothers, S.J., A Critical Analysis of LIGO's Recent Detection of Gravitational Waves Caused by Merging Black Holes, *Hadronic Journal*, n.3, Vol. 39, 2016, pp.271-302, http://vixra.org/pdf/1603.0127v4.pdf

[10] Crothers, S.J., The Australian Education System is Broken, http://www.principia-scientific.org/australian-education-system-broken.html

[11] http://www.independent.co.uk/news/world/australasia/scientist-warns-world-to-think-twice-before-replying-to-alien-signals-from-outer-space-10408201.html