Rebuttal of Bruhn, Physica Scripta, 74, (2006), 1-2

Document 1 on the Lorentz Transformation

The correct way to Lorentz transform the B Cyclic theorem is well known and described in great detail in the literature. There is no flaw in M.W. Evans, Physica Scripta, 61, 513-7 (2000). This so-called criticism by Bruhn is entitled "Lorentz condition" but he does not deal with this at all. This is a personal attack.

a) Bruhn refers to an eq. (1.1) which does not appear in the text until half way down page 2. The real part of $\mathbf{B}^{(1)}$ is:

$$\mathrm{Re}\left(\frac{B^{(0)}}{\sqrt{2}}(\mathbf{i}-i\mathbf{j})(\cos\phi + i\sin\phi)\right)$$

$$= \frac{B^{(0)}}{\sqrt{2}}\left(\mathbf{i}\cos\phi + \mathbf{j}\sin\phi\right). \quad -(1)$$

This is trivially apparent.

b) The Bruhn equation (1.5) is trivial:

$$\frac{1}{2}\left(B_X^2 + B_Y^2\right) = B_Z^2. \quad -(2)$$

c) After Lorentz transformation, assuming that Bruhn has got his maths right:

$$\frac{1}{2}\left(B_X'^2 + B_Y'^2\right) = \left(\frac{1-\beta}{1+\beta}\right)B_Z'^2 \quad -(3)$$

2) Equations (2) and (3) demonstrate Lorentz covariance of the B Cyclic Theorem. This is because eq. (3) has the same form as eq. (2).

The factor β is:

$$\beta = \frac{v}{c} \qquad — (4)$$

However, the B Cyclic Theorem applies to a wave travelling at c. Therefore in eq. (4):

$$v = 0 \qquad — (5)$$

so eq. (3) is the same as eq. (2), Q.E.D.

The argument is that an electromagnetic plane wave travelling at c ($\underline{B}^{(1)} = \underline{B}^{(2)*}$) cannot travel faster than c.

Conclusion

Bruhn does not know this rule. He has once more deliberately contrived an "error". This is disgraceful and unethical.

Document Two

This is again a dishonest document which contrives to find an "error" in Physica Scripta, 61, 513 (2000). The "argument" by Bruhn is obscure. As usual I point

3) out where the deliberate dishonesty by Bruhn occurs.

a) Eqs. (2.1) to (2.2) by Bruhn merely copy out what was given in Physica Scripta, 61, 513-7 (2000).

b) However, it is nowhere assumed in that paper that Bruhn's eq. (1.4) leads to Bruhn's eq. (2.1) (2.2). This is the usual dishonesty at work again.

c) Bruhn just makes mud out of a clear original argument. The purpose is personal animosity and attempted discrediting of a valid theory.

d) The original argument is stated by:

$$\underline{\nabla} \cdot \underline{B} = 0 \quad -(1)$$

$$\underline{\nabla} \cdot \underline{E} = \rho_0 / \epsilon_0 \quad -(2)$$

$$\underline{\nabla} \times \underline{E} + \frac{\partial \underline{B}}{\partial t} = \underline{0} \quad -(3)$$

$$\underline{\nabla} \times \underline{B} - \frac{1}{c^2}\frac{\partial \underline{E}}{\partial t} = \mu_0 \underline{J} \quad -(4)$$

$$\underline{E} = -\frac{\partial \underline{A}}{\partial t} - \underline{\nabla} \phi \quad -(5)$$

$$\underline{B} = \underline{\nabla} \times \underline{A} \quad -(6)$$

+) A wave equation can be constructed by substituting eq. (5) into eq. (4), using eq. (6):

$$\underline{\nabla} \times (\underline{\nabla} \times \underline{A}) + \frac{1}{c^2}\frac{\partial}{\partial t}\left(\frac{\partial \underline{A}}{\partial t} + \underline{\nabla}\phi\right) = \mu_0 \underline{J} \quad -(7)$$

Now use:

$$\underline{\nabla} \times (\underline{\nabla} \times \underline{A}) = \underline{\nabla}(\underline{\nabla} \cdot \underline{A}) - \nabla^2 \underline{A} \quad -(8)$$

so:

$$\left(\nabla^2 \underline{A} - \frac{1}{c^2}\frac{\partial^2 \underline{A}}{\partial t^2}\right) - \underline{\nabla}(\underline{\nabla} \cdot \underline{A}) - \frac{1}{c^2}\frac{\partial}{\partial t}(\underline{\nabla}\phi) = -\mu_0 \underline{J} \quad -(9)$$

i.e.

$$\Box \underline{A} = \mu_0 \underline{J} + \underline{\nabla}(\underline{\nabla} \cdot \underline{A}) + \frac{1}{c^2}\frac{\partial}{\partial t}(\underline{\nabla}\phi) \quad -(10)$$

The Lorenz gauge is

$$\partial_\mu A^\mu = 0 \quad -(11)$$

i.e.

$$\boxed{\Box \underline{A} = \mu_0 \underline{J}} \quad -(12)$$

If this is not used, there exists a current density:

5)
$$\underline{J}(\text{vac}) = \frac{1}{\mu_0}\left(\underline{\nabla}(\underline{\nabla}\cdot\underline{A}) + \frac{1}{c^2}\frac{\partial}{\partial t}(\underline{\nabla}\phi)\right) \quad -(13)$$

It follows that use of eq. (4) with eqs. (5) and (6) implies this current density. The Lorenz gauge (11) means:

$$\frac{1}{c}\frac{\partial A_0}{\partial t} + \underline{\nabla}\cdot\underline{A} = 0 \quad -(14)$$

because:

$$\partial_\mu = \left(\frac{1}{c}\frac{\partial}{\partial t}, \underline{\nabla}\right) \quad -(15)$$

$$A^\mu = (A_0, \underline{A}) \quad -(16)$$

So if one uses eq. (14), $\underline{J}(\text{vac})$ vanishes. The vacuum current $\underline{J}(\text{vac})$ does not rely on the presence of matter, whereas $\underline{J}$ comes from matter.

This is all very well known.

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Phys. Scr. **74** (2006) 1–2 UNCORRECTED PROOF

No Lorentz property of M W Evans' $O(3)$-symmetry law*

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Abstract

The paper (Evans 2000 *Phys. Scr.* **61** 287–91) 'On the Nature of the $B^{(3)}$ Field' essentially refers to a hypothesis that was proposed in 1992 by M W Evans: Evans claimed that a so-called $O(3)$-symmetry of electromagnetic fields should exist due to an additional constant longitudinal 'ghost field' $B^{(3)}$ accompanying the well-known transversal plane em waves. Evans considered this symmetry, a fixed relation between the transversal and the longitudinal amplitudes of the wave, as a *new law of electromagnetics*. In the paper (Evans 2000) in this Journal the authors claim 'that the Maxwell-Heaviside theory is incomplete and limited' and should be replaced with Evans' $O(3)$-theory the centre of which is Evans' $O(3)$-symmetry law. Later on, since 2002, this $O(3)$-symmetry became the centre of Evans' CGUFT which he recently renamed as ECE Theory. A law of Physics must be invariant under admissible coordinate transforms, namely under Lorentz transforms. A plane wave remains a plane wave also when seen from arbitrary other inertial systems. Therefore, Evans' $O(3)$-symmetry law should be valid in all inertial systems. To check the validity of Evans' $O(3)$-symmetry law in other inertial systems, we apply a longitudinal Lorentz transform to Evans' plane em wave (the ghost field included). As is well-known from SRT and recalled here the transversal amplitude decreases while the additional longitudinal field remains unchanged. Thus, Evans' $O(3)$-symmetry cannot be invariant under (longitudinal) Lorentz transforms: Evans' $O(3)$-symmetry is no valid law of Physics. Therefore it is impossible to draw any valid conclusions from that *wrong* $O(3)$-hypothesis. Especially the paper (Evans 2000) has no scientific basis.

Q1 PACS number: xxx

1. Evans' $O(3)$-symmetry

The claim of $O(3)$-symmetry is a central concern of Evans' considerations since 1992. The reader will find a historical overview in [2 (section 5)] written by A Lakhtakia. Among a lot of papers Evans has written five books on 'The Enigmatic Photon' that deal with the claimed $O(3)$-symmetry of electromagnetic fields.

In [3 (chapter 1.2)] Evans considers a circularly polarized plane electromagnetic wave propagating in z-direction. Using the electromagnetic phase

$$\Phi = \omega t - \kappa z \qquad [3; (1.38)]$$

where $\kappa = \omega/c$. Evans describes the wave relative to his complex circular basis [3; (1.41)], see also [4 (appendix 1)].

The magnetic field is given by

$$\begin{aligned}
\mathbf{B}^{(1)} &= B^{(0)}\mathbf{q}'^{(1)} = \frac{1}{\sqrt{2}}B^{(0)}(\mathbf{i} - \mathrm{i}\mathbf{j})\mathrm{e}^{\mathrm{i}\Phi},\\
\mathbf{B}^{(2)} &= B^{(0)}\mathbf{q}'^{(1)} = \frac{1}{\sqrt{2}}B^{(0)}(\mathbf{i}+ = \mathrm{i}\mathbf{j})\mathrm{e}^{-\mathrm{i}\Phi}, \qquad [3; (1.43)]\\
\mathbf{B}^{(3)} &= B^{(0)}\mathbf{q}'^{(3)} = B^{(0)}\mathbf{k},
\end{aligned}$$

satisfying Evans' 'cyclic $O(3)$-symmetry relations'

$$\begin{aligned}
\mathbf{B}^{(1)} \times \mathbf{B}^{(2)} &= \mathrm{i}B^{(0)}\mathbf{B}^{(3)*},\\
\mathbf{B}^{(2)} \times \mathbf{B}^{(3)} &= \mathrm{i}B^{(0)}\mathbf{B}^{(1)*}, \qquad [3; (1.44)]\\
\mathbf{B}^{(3)} \times \mathbf{B}^{(1)} &= \mathrm{i}B^{(0)}\mathbf{B}^{(2)*}.
\end{aligned}$$

* A remark on a former paper [1] in this journal.

Due to M W Evans' the corresponding electric field is given by

$$\mathbf{E}^{(1)} = -\frac{1}{\sqrt{2}}E^{(0)}(\mathrm{i}\mathbf{i}+\mathbf{j})\,\mathrm{e}^{\mathrm{i}\Phi},$$
$$\mathbf{E}^{(2)} = \frac{1}{\sqrt{2}}E^{(0)}(\mathrm{i}\mathbf{i}-\mathbf{j})\,\mathrm{e}^{-\mathrm{i}\Phi}, \qquad [3;\,(1.85)]$$
$$\mathbf{E}^{(3)} = -\mathrm{i}E^{(0)}\mathbf{k}.$$

The relation between $E^{(0)}$ and $B^{(0)}$ is

$$E^{(0)} = cB^{(0)}. \qquad [3;\,(1.87)]$$

We can determine the real representations of the involved fields: Due to $\mathbf{B}^{(2)} = \mathbf{B}^{(1)*}$ and $\mathbf{E}^{(2)} = \mathbf{E}^{(1)*}$ the complex fields [3; (1.43)] and [3; (1.85)] belong to the real fields

$$\mathbf{B} = \mathbf{B}^{(1)}+\mathbf{B}^{(2)}+\mathbf{B}^{(3)} = B_x\mathbf{i}+B_y\mathbf{j}+B_z\mathbf{k}$$

and

$$\mathbf{E} = \mathbf{E}^{(1)}+\mathbf{E}^{(2)}+\mathbf{E}^{(3)} = E_x\mathbf{i}+E_y\mathbf{j}+E_z\mathbf{k}.$$

Insertion of [3; (1.43)] and [3; (1.85)] and coefficient matching yields

$$B_x = \frac{1}{\sqrt{2}}B^{(0)}\cos\Phi, \qquad B_y = \frac{1}{\sqrt{2}}B^{(0)}\sin\Phi, \qquad B_z = B^{(0)}, \qquad (1.1)$$

$$E_x = \frac{1}{\sqrt{2}}E^{(0)}\sin\Phi, \qquad E_y = -\frac{1}{\sqrt{2}}E^{(0)}\cos\Phi, \qquad E_z = E^{(0)}. \qquad (1.2)$$

Summing the equations in (1.1) with combination factors 1, $\pm\mathrm{i}$ and comparing with equations [3; (1.43)] yields

$$(B_x+\mathrm{i}B_y)(\mathbf{i}-\mathrm{i}\mathbf{j}) = 2\mathbf{B}^{(1)}, \qquad (B_x-\mathrm{i}B_y)(\mathbf{i}+\mathrm{i}\mathbf{j}) = 2\mathbf{B}^{(2)} \qquad (1.3)$$

and therefore for further use in rewriting of the first equation of [3; (1.44)]

$$\mathbf{B}^{(1)}\times\mathbf{B}^{(2)} = \tfrac{1}{2}(B_x+\mathrm{i}B_y)(B_x-\mathrm{i}B_y)\mathrm{i}\mathbf{k} = \tfrac{1}{2}(B_x^2+B_y^2)\mathrm{i}\mathbf{k} \qquad (1.4)$$

while the last equations of [3; (1.43)] and (1.1) yield

$$B^{(0)}\mathbf{B}^{(3)*} = \mathrm{i}\mathbf{k}B^{(0)2} = \mathrm{i}\mathbf{k}B_z^2.$$

Thus, one of Evans' 'cyclic symmetry relations', the first rule of [3; (1.44)], is equivalent to

$$\tfrac{1}{2}(B_x^2+B_y^2) = B_z^2. \qquad (1.5)$$

The first two equations of [3; (1.43)] and [3; (1.85)] describe a circularly polarized plane wave propagating in z-direction. The third equations, however, contain Evans' $O(3)$-law from 1992, saying that the well-known plane wave is always accompanied by a constant longitudinal magnetic 'ghost field' $B^{(3)}$, the *size* of which—*this is important*—is given by the third equation of [3; (1.43)], or by the first equation of [3; (1.44)], which in real formulation is our equation (1.5).

2. The transformation behaviour of the $O(3)$-symmetry law

If Evans' $O(3)$-law were a *law of Physics* then it must be *invariant* under the admissible coordinate transforms, i.e. under Lorentz transforms.

Therefore we consider the wave as observed from other coordinate systems S' in constant motion $\mathbf{v} = v\mathbf{k}$ relative to our original Cartesian coordinate system S. The transformation rules for the electromagnetic field are well-known (where $\beta = v/c$, $\gamma = \sqrt{1-\beta^2}$):

$$E'_x = \frac{1}{\gamma}(E_x-\beta B_y), \qquad E'_y = \frac{1}{\gamma}(E_y+\beta B_x), \qquad E'_z = E_z, \qquad (2.1)$$

$$B'_x = \frac{1}{\gamma}\left(B_x+\frac{\beta}{c}E_y\right), \quad B'_y = \frac{1}{\gamma}\left(B_y-\frac{\beta}{c}E_x\right), \quad B'_z = B_z. \qquad (2.2)$$

We shall check the first rule of Evans' $O(3)$-symmetry law [3; (1.44)] in our equivalent real formulation (1.5). Therefore we are now going to transform the wave (1.1)–(1.2) to the coordinate frame S' by means of the transformation rules (2.1)–(2.2) to obtain

$$B'_x = \frac{1-\beta}{\gamma}B^{(0)}\sqrt{2}\cos\Phi = \frac{1-\beta}{\gamma}B_x,$$
$$B'_y = \frac{1-\beta}{\gamma}B^{(0)}\sqrt{2}\sin\Phi = \frac{1-\beta}{\gamma}B_y, \qquad (2.3)$$
$$B'_z = B_z,$$

which yields

$$\tfrac{1}{2}(B_x'^2+B_y'^2) = \frac{1-\beta}{1+\beta}\,\tfrac{1}{2}(B_x^2+B_y^2) = \frac{1-\beta}{1+\beta}B_z^2$$
$$= \frac{1-\beta}{1+\beta}B_z'^2 < B_z'^2 \quad (0<\beta<1).$$

Hence Evans' first $O(3)$-symmetry relation (1.5) in S', the equation

$$\tfrac{1}{2}(B_x'^2+B_y'^2) = B_z'^2,$$

is not fulfilled: Evans' cyclical $O(3)$-symmetry is not Lorentz invariant and hence no law of Physics.

Therefore, no valid conclusions can be drawn from that wrong $O(3)$-hypothesis.

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No energy to be extracted from the vacuum*

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Abstract
A few years ago a hopeful article (Evans 2000 *Phys. Scr.* **61** 513–7) appeared in this journal promising that according to its 15 authors' opinion the pending energy crisis could be solved by 'extracting energy from the vacuum'. However, in the past years the energy price has grown to unthinkable heights: a reason for having a look at the promised 'Energy from the Vacuum' in (Evans 2000). So we'll do below and shall arrive at a great disappointment: the 15 authors were in error; their vacuum energy stems from a simple flaw of thinking by misinterpreting the well-known Lorenz term of the classical Maxwell gauge theory. Their miraculous conclusion should have made the authors suspicious, that just the Lorenz term should yield a vacuum current. Surely, its a pity that vacuum currents and vacuum energy in (Evans 2000) have their origin merely in a simple flaw of thinking, and all further speculations for a vacuum energy density are in vain. However, better to return to reality.

Quote: Abstract of [1]: Great announcements...

It is shown that if the Loren(t)z condition is discarded, the Maxwell–Heaviside field equations become the Lehnert equations, indicating the presence of charge density and current density in the vacuum. The Lehnert equations are a subset of the O(3) Yang–Mills field equations. Charge and current density in the vacuum are defined straightforwardly in terms of the vector potential and scalar potential, and are conceptually similar to Maxwell's displacement current, which also occurs in the classical vacuum. A demonstration is made of the existence of a time dependent classical vacuum polarization which appears if the Loren(t)z condition is discarded. Vacuum charge and current appear phenomenologically in the Lehnert equations but fundamentally in the O(3) Yang–Mills theory of classical electrodynamics. The latter also allows for the possibility of the existence of vacuum topological magnetic charge density and topological magnetic current density. Both O(3) and Lehnert equations are superior to the Maxwell–Heaviside equations in being able to describe phenomena not amenable to the latter. In theory, devices can be made to extract the energy associated with vacuum charge and current.

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1. The classical result of gauge theory

We recall to the readers that the Maxwell equations with given inhomogenities, the charge density ρ and the current density $\mathbf{j}$, can be solved by means of potentials $\mathbf{A}$, Φ, which are solutions of the coupled differential equations

$$\frac{1}{c^2}\mathbf{A}_{tt} - \Delta\mathbf{A} + \nabla\left(\nabla\cdot\mathbf{A} + \frac{1}{c^2}\Phi_t\right) = \mu_o\mathbf{j} \qquad (1.1)$$

and

$$\frac{1}{c^2}\Phi_{tt} - \Delta\Phi - \left(\nabla\cdot\mathbf{A} + \frac{1}{c^2}\Phi_t\right)_t = \frac{1}{\epsilon_o}\rho. \qquad (1.2)$$

* A review of a former article in this journal.

without any further coupling between $\mathbf{A}$ and Φ to obtain the solutions $\mathbf{B} = \nabla \times \mathbf{A}$ and $\mathbf{E} = -\nabla\Phi - \mathbf{A}_t$ of the inhomogeneous Maxwell equations. It is the merit of the Danish physicist Ludvig Lorenz (1829–1891) (not H A Lorentz who has a lot of other merits in Physics) to propose in 1867 the condition

$$\nabla \cdot \mathbf{A} + \frac{1}{c^2}\Phi_t = 0, \qquad (1.3)$$

nowadays so-called *Lorenz gauge*, to be imposed on the potentials in order to reduce the equations (1.1)–(1.2) to two *separate* inhomogeneous wave equations, particular solutions of which have well-known integral representations.

$$\frac{1}{c^2}\mathbf{A}_{tt} - \Delta\mathbf{A} = \mu_o\mathbf{j} \qquad (1.4)$$

and

$$\frac{1}{c^2}\Phi_{tt} - \Delta\Phi = \frac{1}{\epsilon_o}\rho. \qquad (1.5)$$

1.1. Result

(a) The 'Lorenz-free' case: *without* Lorenz gauge (1.3) the Ampère–Maxwell equation $\nabla \times \mathbf{H} = \mathbf{j} + \mathbf{D}_t$ is equivalent to equation (1.1).
(b) The case of Lorenz gauge: *with* Lorenz gauge (1.3) the Ampère–Maxwell equation $\nabla \times \mathbf{H} = \mathbf{j} + \mathbf{D}_t$ is equivalent to equation (1.4).

Both cases should not be confused as was done in [1].

2. The flaw of thinking in [1]

The authors of [1] refer to a former paper [2] where two of them had described the gauge process quite correctly not differing from the textbooks. However, as we shall see, the leading author of [1] has made a wrong use of the equations in [2] by confusing the above cases (a) and (b).

He is intending to treat the vacuum case, where no charge and no current is present, of 'Classical Electrodynamics without the Loren(t)z Condition', i.e. he considers case (a). So he starts with the reduced 'Lorenz free' equation (1.1) with $\mathbf{j} = 0$, with the equation

$$\frac{1}{c^2}\mathbf{A}_{tt} - \Delta\mathbf{A} + \nabla\left(\nabla \cdot \mathbf{A} + \frac{1}{c^2}\Phi_t\right) = \mathbf{0}, \qquad (2.1)$$

and, having in mind the Lorenz *gauged* version (1.4), he defines a 'vacuum current' $\mathbf{j_A}$ by his equation

$$-\nabla\left(\nabla \cdot \mathbf{A} + \frac{1}{c^2}\Phi_t\right) =: \mu_o\mathbf{j_A}. \qquad [2;\,(10)]$$

Therewith equation (2.1) takes the form

$$\frac{1}{c^2}\mathbf{A}_{tt} - \Delta\mathbf{A} = \mu_o\mathbf{j_A}. \qquad (2.2)$$

Now we come to the *magic trick*: our author remembers equation (2.2) to belong to the Ampère–Maxwell equation and so he concludes

$$\nabla \times \mathbf{H} = \mathbf{j_A} + \mathbf{D}_t, \qquad [2;\,(20)]$$

ignoring that this is true only under Lorenz gauge (case (a)) while he had decided to consider the Lorenz-free case (a). Therefore equation [2; (20)] is wrong.

For the way back to the Ampère–Maxwell equation the Lorenz term (1.3) is essential and must be 'reimbursed', i.e. *correctly* we have to start with the Lorenz-free version of equation (2.2), i.e. with

$$\frac{1}{c^2}\mathbf{A}_{tt} - \Delta\mathbf{A} + \nabla\left(\nabla \cdot \mathbf{A} + \frac{1}{c^2}\Phi_t\right) = \mu_o\mathbf{j}$$
$$:= \mu_o\mathbf{j_A} + \nabla\left(\nabla \cdot \mathbf{A} + \frac{1}{c^2}\Phi_t\right) \qquad (2.3)$$

to obtain the Ampère–Maxwell equation $\nabla \times \mathbf{H} = \mathbf{j} + \mathbf{D}_t$. However, due to equation (2.3) and the definition [2; (10)] of the vacuum current $\mathbf{j_A}$ we have

$$\mu_o\mathbf{j} = \mu_o\mathbf{j_A} + \nabla\left(\nabla \cdot \mathbf{A} + \frac{1}{c^2}\Phi_t\right) = \mathbf{0}, \qquad (2.4)$$

thus, the correct calculation yields the ZERO vacuum current $\mathbf{j} = \mathbf{0}$.

For similar reasons there is no vacuum charge density $\rho_{\mathbf{A}}$.

3. Final remark

Logical errors may occur sometimes. However, the attained em miraculous result in the case under review should have arousen somebodies suspicion; the paper had 15 authors. But they all were gullible, and so they did not recognize that both vacuum current and vacuum energy had a very trivial origin: 'a mere flaw of thinking'.

Thus there is no reason to speculate about vacuum current and vacuum energy and even applying the '$O(3)$ Yang–Mills Theory' as one of the authors (probably M W Evans, author of the $O(3)$-hypothesis) proposed.

Besides: M W Evans' $O(3)$ theory is not Lorentz invariant and thus is no physical theory, cf [3].

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