RIGOROUS CONSERVATION OF ANTISYMMETRY IN ECE2 ELECTRODYNAMICS

by

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ABSTRACT

The complete set of antisymmetry laws of ECE2 electrodynamics are solved together with the field equations. Conservation of antisymmetry is a fundamental law of physics, one which is violated by the standard model. The ECE wave equation completes the set of available equations.

Keywords: ECE2 theory, conservation of antisymmetry, electrodynamics.

UFT388

1. INTRODUCTION

In recent papers of this series, {1 - 12}, conservation of antisymmetry has been proven rigorously for ECE2 electrostatics and magnetostatics. In this paper, the law of conservation of antisymmetry is proven for ECE2 electrodynamics. In section 2, the trace antisymmetry law is introduced and the ECE wave equation used to complete the set of available equations, the antisymmetry equations and the field equations. In Section 3 some of the structure of spacetime (or vacuum or aether) is mapped through the use of the spin connection four vector.

This paper is a short synopsis of the notes accompanying UFT388 on www.aias.us and www.upitec.org (combined sites). Notes 388(1) and 388(2) give details of a method in which the material or circuit is assumed to be approximately free of the vacuum. Note 388(2) gives the complete set of equations. Note 388(4) develops the trace antisymmetry equation, or Lindstrom constraint, first given in UFT354 and UFT366 (volume two of "The Principles of "ECE"). Section 2 is based on Notes 388(4) and 388(6).

2. THE SET OF ANTISYMMETRY EQUATIONS.

The complete set of available equations includes the ECE wave equation {1 - 12}:

$$(\square + R) A^a_\mu = 0 \qquad -(1)$$

where R is a scalar curvature and A^a_μ the vector potential of ECE theory:

$$A^a_\mu = A^{(0)} q^a_\mu \qquad -(2)$$

where q^a_μ is the Cartan tetrad and $A^{(0)}$ proportionality constant. For each index a:

where {1 - 12}

$$\square A_\mu = -R A_\mu = \mu_0 J_\mu \quad -(3)$$

Here J_μ is the four current density and μ_0 is the vacuum permeability. Eq. (3) implies that:

$$\square \phi = \rho / \epsilon_0 \quad -(4)$$

and

$$\square \underline{A} = \mu_0 \underline{J} \quad -(5)$$

where ϕ is the scalar potential, $\underline{A}$ is the vector potential, ρ is the charge density, $\underline{J}$ is the current density and ϵ_0 the vacuum permittivity.

Note carefully that the wave equation is derived without use of the Lorenz condition , and that R is well defined geometrically {1 - 12}. It is also important to note that a material or circuit is always influenced by the vacuum, so all quantities in ECE2 electrodynamics are always influenced by the vacuum. This influence is evident in the well known radiative corrections such as the electron g factor and the Lamb shift {1 - 12}.

As described in immediately preceding papers the electric and magnetic antisymmetry equations are:

$$\underline{E} = -\underline{\nabla}\phi + \underline{\omega}\phi = -\frac{\partial \underline{A}}{\partial t} - \omega_0 \underline{A} \quad -(6)$$

$$\underline{B} = \underline{\nabla} \times \underline{A} - \underline{\omega} \times \underline{A} \quad -(7)$$

$$\frac{\partial A_Z}{\partial Y} + \frac{\partial A_Y}{\partial Z} = \omega_Y A_Z + \omega_Z A_Y \quad -(8)$$

$$\frac{\partial A_X}{\partial Z} + \frac{\partial A_Z}{\partial X} = \omega_Z A_X + \omega_X A_Z \quad -(9)$$

$$\frac{\partial A_Y}{\partial X} + \frac{\partial A_X}{\partial Y} = \omega_X A_Y + \omega_Y A_X \quad -(10)$$

where $\underline{E}$ is the electric field strength, $\underline{B}$ the magnetic flux density and where:

$$\omega^\mu = \left(\frac{\omega_0}{c}, \underline{\omega} \right) \quad -(11)$$

is the spin connection four-vector. The spin connection maps the structure of the vacuum and is not defined in the standard model (the Maxwell Heaviside (MH) theory). The trace antisymmetry equation or Lindstrom constraint is:

$$\frac{1}{c^2} \left(\frac{\partial}{\partial t} + \omega_0 \right) \phi = \left(\underline{\nabla} - \underline{\omega} \right) \cdot \underline{A} \quad -(12).$$

and shows that the covariant derivatives of the scalar and vector potentials are the same.

As shown in Note 388(4), the Lindstrom constraint is derived from the tetrad postulate {1 - 12}

$$\Gamma^a_{\mu\nu} = \partial_\mu q^a_\nu + \omega^a_{\mu b} q^b_\nu \quad -(13)$$

where Γ is the mixed index gamma connection, related to the Christoffel connection, where $\omega^a_{\mu b}$ is the Cartan spin connection and q^b_ν is the Cartan tetrad. By antisymmetry:

$$\Gamma^a_{\mu\nu} = -\Gamma^a_{\nu\mu}. \quad -(14)$$

From Note 379(5) on www.aias.us:

$$\omega^a_{\mu b} q^b_\nu = \omega^a_\mu q_\nu. \quad -(15)$$

For each index a it follows that:

$$\Gamma_{\mu\nu} = \partial_\mu q_\nu + \omega_\mu q_\nu . \quad -(16)$$

Since $\Gamma_{\mu\nu}$ is antisymmetric by definition, its trace vanishes:

$$\Gamma_{00} + \Gamma_{11} + \Gamma_{22} + \Gamma_{33} = 0 \quad -(17)$$

using the ECE postulate (2):

$$\partial_0 A_0 + \omega_0 A_0 + \sum_{i=1}^{3} \partial_i A_i + \omega_i A_i = 0 \quad -(18)$$

where:

$$\partial_\mu = \left(\frac{1}{c} \frac{\partial}{\partial t}, \underline{\nabla} \right) \quad -(19)$$

$$A_\mu = \left(\frac{\phi}{c}, -\underline{A} \right) \quad -(20)$$

$$\omega_\mu = \left(\frac{\omega_0}{c}, -\underline{\omega} \right) \quad -(21)$$

Eq. (12) follows, Q. E. D.

Note carefully that the empirical Lorenz condition is not used in the derivation of Eq. (12). This is an advantage because the Lorenz condition is an arbitrary or empirical construct of the standard model, used without proof.

The well known ECE2 field equations:

$$\underline{\nabla} \cdot \underline{B} = 0 \quad -(22)$$

$$\underline{\nabla} \times \underline{E} + \frac{\partial \underline{B}}{\partial t} = \underline{0} \quad -(23)$$

$$\underline{\nabla} \cdot \underline{E} = \rho / \epsilon_0 \quad -(24)$$

$$\underline{\nabla} \times \underline{B} - \frac{1}{c^2} \frac{\partial \underline{E}}{\partial t} = \mu_0 \underline{J} \quad -(25)$$

must be used together with the antisymmetry constraints and ECE field equation. Note carefully that the MH theory does not conserve antisymmetry {1 - 12}, and is thereby refuted and obsolete, ,and that there are several new fundamental laws of physics in the ECE2 electrodynamics. This is significant progress in understanding.

From Eqs. (4) and (24):

$$\underline{\nabla} \cdot \underline{E} = \Box \phi = \rho / \epsilon_0 \quad -(26)$$

and from Eqs. (5) and (25):

$$\underline{\nabla} \times \underline{B} - \frac{1}{c^2} \frac{\partial \underline{E}}{\partial t} = \Box \underline{A} = \mu_0 \underline{J} \quad -(27)$$

Eqs. (26) and (27) appear superficially to have the same format as the MH theory, but $\underline{E}$ and $\underline{B}$ are defined in a completely different way on the ECE2 level. The latter is developed in a space with finite torsion and curvature, MH is developed in Minkowski space, in which torsion and curvature are not defined.

It is recommended that the following computational and graphical procedures be used. However, many other procedures are possible.

1) Measure ρ and $\underline{J}$ experimentally in a material or circuit. Find ϕ and $\underline{A}$ from Eqs. (26) and (27) by numerical integration.

2) Knowing $\underline{A}$, the spin connection vector $\underline{\omega}$ is found by solving Eqs. (8) to (10) as in immediately preceding papers.

3) Knowing $\underline{A}$, $\underline{\omega}$ and ϕ, $\underline{E}$ is found from Eq. (6), and $\underline{B}$ is found from Eq. (7).

Another procedure is as follows:

1) Measure $\underline{E}$ and $\underline{B}$ in a material or circuit.

2) Find ρ and ϕ from Eq. (26).

3) Find $\underline{A}$ and $\underline{J}$ from eq. (27).

4) Find $\underline{\omega}$ from Eqs. (8) to (10).

The homogeneous field equations (22) and (23) must be obeyed. From Eqs. (7) and (22) this implies that:

$$\underline{\nabla} \cdot \underline{\omega} \times \underline{A} = 0. \quad -(28)$$

Defining:

$$\underline{\nabla} \times \underline{A}_1 := \underline{\omega} \times \underline{A} \quad -(29)$$

then Eq. (28) is obeyed by vector algebra:

$$\underline{\nabla} \cdot \underline{\nabla} \times \underline{A}_1 = 0 \quad -(30)$$

and it follows that:

$$\underline{B} = \underline{\nabla} \cdot \underline{A}(\text{total}) \quad -(31)$$

where the total vector potential is:

$$\underline{A}(\text{total}) = \underline{A} + \underline{A}_1 \quad -(32)$$

Furthermore, define:

$$\underline{E} = -\underline{\nabla}\phi + \underline{\omega}\phi = -\underline{\nabla}\phi - \frac{\partial \underline{A}}{\partial t}(\text{total}) \quad -(33)$$

i. e.

$$\underline{\omega}\phi := -\frac{\partial \underline{A}}{\partial t}(\text{total}) \quad -(34)$$

From Eqs. (31) and (33) it follows that:

$$\underline{\nabla} \times \underline{E} + \frac{\partial \underline{B}}{\partial t} = \underline{0} \quad -(35)$$

Q. E. D.

Finally, the scalar spin connection ϕ_0 must obey two equations:

$$\underline{E} = -\frac{\partial \underline{A}}{\partial t} - \omega_0 \underline{A} \quad -(36)$$

and

$$\frac{1}{c^2}\left(\frac{\partial \phi}{\partial t} + \omega_0 \phi\right) = (\underline{\nabla} - \underline{\omega}) \cdot \underline{A} \, . \quad -(37)$$

From Eq. (37):

$$\omega_0 = \frac{1}{\phi}\left(c^2 (\underline{\nabla} - \underline{\omega}) \cdot \underline{A} - \frac{\partial \phi}{\partial t}\right) . \quad -(38)$$

From Eqs. (33) and (36):

$$-\frac{\partial \underline{A}(\text{total})}{\partial t} = \omega_0 \underline{A} \quad -(39)$$

so $\underline{A}(\text{total})$ can be found using ω_0 of Eq. (38).

From Eq. (39):

$$\underline{A}(\text{total}) = -\int \underline{\omega} \phi \, dt + \underline{A}_2 \quad -(40)$$

where $\underline{A}_2$ is a constant of integration, another vector potential:

$$\underline{A}_2 = \underline{A}(\text{total}) + \int \underline{\omega} \phi \, dt . \quad -(41)$$

So the entire set of equations can be solved, Q. E. D. They are all fundamental laws of physics, and rigorously conserve antisymmetry. The Maxwell Heaviside field equations do not conserve antisymmetry, so the standard model is refuted and replaced by ECE2 electrodynamics.

3. MAPPING THE VACUUM

Section by co author Horst Eckardt

Rigorous conservation of antisymmetry in ECE2 electrodynamics

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3 Mapping the vacuum

We investigate two kinds of electromagnetic waves as examples for time-dependent electrodynamic problems. The associated vacuum structure is investigated.

3.1 Circularly polarized plane wave

We start with circularly polarized plane waves with three polarization directions, inducing the $B^{(3)}$ field, which is a vacuum field in direction of propagation. The $B^{(3)}$ field is defined by

$$\mathbf{B}^{(3)*} = -\frac{i\kappa}{A^{(0)}}\mathbf{A} \times \mathbf{A}^* \tag{42}$$

with complex vector potential $\mathbf{A}$ and constants κ and $A^{(0)}$. There are three polarization directions of $\mathbf{A}$ with

$$\mathbf{A} \times \mathbf{A}^* = \mathbf{A}^{(1)} \times \mathbf{A}^{(2)} \tag{43}$$

and

$$\mathbf{A}^{(3)} = \mathbf{0}. \tag{44}$$

From this definition follows the B cyclic theorem:

$$\mathbf{B}^{(1)} \times \mathbf{B}^{(2)} = i\mathbf{B}^{(0)} \times \mathbf{B}^{(3)*}, \tag{45}$$
$$\mathbf{B}^{(3)} \times \mathbf{B}^{(1)} = i\mathbf{B}^{(0)} \times \mathbf{B}^{(2)*}, \tag{46}$$
$$\mathbf{B}^{(2)} \times \mathbf{B}^{(3)} = i\mathbf{B}^{(0)} \times \mathbf{B}^{(1)*}. \tag{47}$$

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The vector potential is defined by

$$\mathbf{A}^{(1)} = \frac{A^{(0)}}{\sqrt{2}} \exp\left(i(\omega_t t - \kappa_Z)\right) \begin{bmatrix} 1 \\ -i \\ 0 \end{bmatrix}, \tag{48}$$

$$\mathbf{A}^{(2)} = \frac{A^{(0)}}{\sqrt{2}} \exp\left(-i(\omega_t t - \kappa_Z)\right) \begin{bmatrix} 1 \\ i \\ 0 \end{bmatrix} \tag{49}$$

with time frequency ω_t and wave number κ_Z. From Eq. (42) follows:

$$\mathbf{B}^{(3)*} = \begin{bmatrix} 0 \\ 0 \\ \kappa A^{(0)} \end{bmatrix}. \tag{50}$$

Because of Eq. (43) we can proceed with one complex-valued potential $\mathbf{A}$. The spin connection obeying the magnetic antisymmetry equations (8-10) then is

$$\boldsymbol{\omega} = \begin{bmatrix} \frac{\kappa_Z}{\sqrt{2}} \exp(i(\omega_t t - \kappa_Z Z)) \\ -i\frac{\kappa_Z}{\sqrt{2}} \exp(i(\omega_t t - \kappa_Z Z)) \\ i\kappa_Z \end{bmatrix}. \tag{51}$$

This means that the vacuum is structured similar to the vector potential, in form of plane waves. In the following we discern the physically acting fields

$$\mathbf{E}_1 = -\frac{\partial \mathbf{A}}{\partial t}, \tag{52}$$

$$\mathbf{B}_1 = \boldsymbol{\nabla} \times \mathbf{A} \tag{53}$$

and the vacuum fields

$$\mathbf{E}_2 = -\omega_0 \mathbf{A}, \tag{54}$$

$$\mathbf{B}_2 = -\boldsymbol{\omega} \times \mathbf{A}. \tag{55}$$

The total fields then are, according to ECE2 theory,

$$\mathbf{E} = \mathbf{E}_1 + \mathbf{E}_2, \tag{56}$$

$$\mathbf{B} = \mathbf{B}_1 + \mathbf{B}_2. \tag{57}$$

From Eqs. (48), (49) and (51) follows that the corresponding fields are

$$\mathbf{E}_1 = \frac{A^{(0)}}{\sqrt{2}} \omega_t \exp(-i(\omega_t t - \kappa_Z Z)) \begin{bmatrix} i \\ -1 \\ 0 \end{bmatrix} \tag{58}$$

$$\mathbf{E}_2 = \frac{A^{(0)}}{\sqrt{2}} \omega_0 \exp(-i(\omega_t t - \kappa_Z Z)) \begin{bmatrix} -1 \\ -i \\ 0 \end{bmatrix} \tag{59}$$

$$\mathbf{B}_1 = \frac{A^{(0)}}{\sqrt{2}} \kappa_Z \exp(-i(\omega_t t - \kappa_Z Z)) \begin{bmatrix} 1 \\ i \\ 0 \end{bmatrix} \tag{60}$$

$$\mathbf{B}_2 = A^{(0)} \kappa_Z \begin{bmatrix} -\frac{1}{\sqrt{2}} \exp(-i(\omega_t t - \kappa_Z Z)) \\ -i\frac{1}{\sqrt{2}} \exp(-i(\omega_t t - \kappa_Z Z)) \\ -i \end{bmatrix} \tag{61}$$

The total magnetic field

$$\mathbf{B} = \boldsymbol{\nabla} \times \mathbf{A} - \boldsymbol{\omega} \times \mathbf{A} = \begin{bmatrix} 0 \\ 0 \\ -iA^{(0)}\kappa_Z \end{bmatrix} \tag{62}$$

only has a imaginary Z component. The X and Y components of $\boldsymbol{\nabla} \times \mathbf{A}$ and $\boldsymbol{\omega} \times \mathbf{A}$ are different from zero but cancel out. This could be the reason why Nicola Tesla mainly relied on electric fields in his transmission experiments. The electric total field does not cancel out and includes vacuum interaction while the total magnetic field is a null field.

The total electric field of the plane waves is

$$\mathbf{E} = \frac{A^{(0)}}{\sqrt{2}} \exp(-i(\omega_t t - \kappa_Z Z)) \begin{bmatrix} i\omega_t - \omega_0 \\ -(\omega_t + i\omega_0) \\ 0 \end{bmatrix}. \tag{63}$$

It makes sense to identify ω_0 with the time frequency ω_t so that

$$\mathbf{E} = \frac{A^{(0)}}{\sqrt{2}} \omega_t \exp(-i(\omega_t t - \kappa_Z Z)) \begin{bmatrix} i - 1 \\ -(i + 1) \\ 0 \end{bmatrix}. \tag{64}$$

In order to inspect the vacuum effects, we test the field equations for the physically effective and vacuum fields separately. For the physically effective fields we obtain

$$\boldsymbol{\nabla} \cdot \mathbf{B}_1 = 0 \tag{65}$$

$$\boldsymbol{\nabla} \times \mathbf{E}_1 + \frac{\partial \mathbf{B}_1}{\partial t} = \mathbf{0} \tag{66}$$

$$\boldsymbol{\nabla} \cdot \mathbf{E}_1 = 0 \tag{67}$$

$$\boldsymbol{\nabla} \times \mathbf{B}_1 - \frac{1}{c^2} \frac{\partial \mathbf{E}_1}{\partial t} = \mathbf{0} \tag{68}$$

i.e. there are no charge and current densities for electromagnetic waves as expected. For this result we had to assume the ordinary vacuum relation between time frequency, wave number and propagation velocity c:

$$\omega_t = c\,\kappa_Z. \tag{69}$$

For the vacuum fields, however, we obtain

$$\boldsymbol{\nabla} \cdot \mathbf{B}_2 = 0 \tag{70}$$

$$\boldsymbol{\nabla} \times \mathbf{E}_2 + \frac{\partial \mathbf{B}_2}{\partial t} = \mu_0\, \mathbf{J}_{m2} \tag{71}$$

$$\boldsymbol{\nabla} \cdot \mathbf{E}_2 = 0 \tag{72}$$

$$\boldsymbol{\nabla} \times \mathbf{B}_2 - \frac{1}{c^2} \frac{\partial \mathbf{E}_2}{\partial t} = \mu_0\, \mathbf{J}_2 \tag{73}$$

with

$$\mu_0\,\mathbf{J}_{m2} = \frac{A^{(0)}}{\sqrt{2}}\omega_t\kappa_Z\exp(-i(\omega_t t-\kappa_Z Z))\begin{bmatrix} i-1\\ -(i+1)\\ 0\end{bmatrix}, \tag{74}$$

$$\mu_0\,\mathbf{J}_2 = \frac{A^{(0)}}{c^2\sqrt{2}}\exp(-i(\omega_t t-\kappa_Z Z))\begin{bmatrix} -(i\,\omega_t^2+c^2\kappa_Z^2)\\ \omega_t^2-i\,c^2\kappa_Z^2\\ 0\end{bmatrix}. \tag{75}$$

There is a vacuum current J_2 and even an magnetic vacuum current J_{m2}. These are not acting visibly in electromagnetic waves.

From the trace antisymmetry equation (12) follows

$$(\boldsymbol{\nabla}-\boldsymbol{\omega})\cdot\mathbf{A} = -A^{(0)}\kappa_Z \tag{76}$$

meaning that there is a type of scalar potential present. A constant potential $\phi=\phi_0$ is a possible solution, giving

$$\phi_0 = \frac{A^{(0)}c^2\,\kappa_Z}{\omega_t}. \tag{77}$$

The real parts of all field vectors are graphed in Figs. 1-3 for unity parameters (except $c=5$) and $t=0$. In Fig. 1 the physically acting fields are plotted. $\mathbf{E}_1$ and $\mathbf{B}_1$ are rotating with a phase shift of 90° as is well known for circularly polarized waves. $\mathbf{A}$ and $\boldsymbol{\omega}$ are both parallel to $\mathbf{B}_1$. The vacuum fields $\mathbf{E}_2$ and $\mathbf{B}_2$ are parallel and antiparallel to $\mathbf{A}$ as can be seen from Fig. 2. In Fig. 3 we have graphed the vacuum currents. These are nearly perpendicular to one another but are phase shifted both to a 45° axis compared to $\mathbf{E}$ and $\mathbf{B}$. This vacuum structure of electromagnetic waves was completely unknown before.

3.2 Circularly polarized wave with radial localization

A second example is a modified (real-valued) plane wave, with a radially decay inversely to the radius $r=\sqrt{X^2+Y^2}$:

$$\mathbf{A} = \begin{bmatrix} \frac{A_0 r_0\cos(\omega_t t-k_Z Z)}{\sqrt{X^2+Y^2}}\\ \frac{A_0 r_0\sin(\omega_t t-k_Z Z)}{\sqrt{X^2+Y^2}}\\ A_3\end{bmatrix} \tag{78}$$

where r_0 is a scaling constant. $\mathbf{A}$ has a non-vanishing constant Z component A_3. This is required to guarantee solutions of the magnetic antisymmetry equations (8-10). From the results it can be seen that setting $A_3=0$ would lead to zero denominators for example in $\boldsymbol{\omega}$. Therefore this component is required. The expressions for $\mathbf{E}_{1,2}$, $\mathbf{B}_{1,2}$ and $\boldsymbol{\omega}$ are computed as for the first example. They are complicated and not listed here. Some of their components are graphed. It is plausible that the $1/r$ dependence leads to source terms $\boldsymbol{\nabla}\cdot\mathbf{A}$ etc. The Lindstrom constraint requires a complicated scalar potential ϕ. There are vacuum currents as well as physically effective currents. The $\mathbf{E}$ and $\mathbf{B}$ fields are also radially decaying in Z direction although this behaviour is not present in $\mathbf{A}$, reminding of a wave packet in three dimensions.

Fig. 4 shows a vector map of the $\mathbf{A}$ field in the XY plane, taken at $Z=1$ (all constants set to unity). The nature of a plane wave would reveal parallel vectors

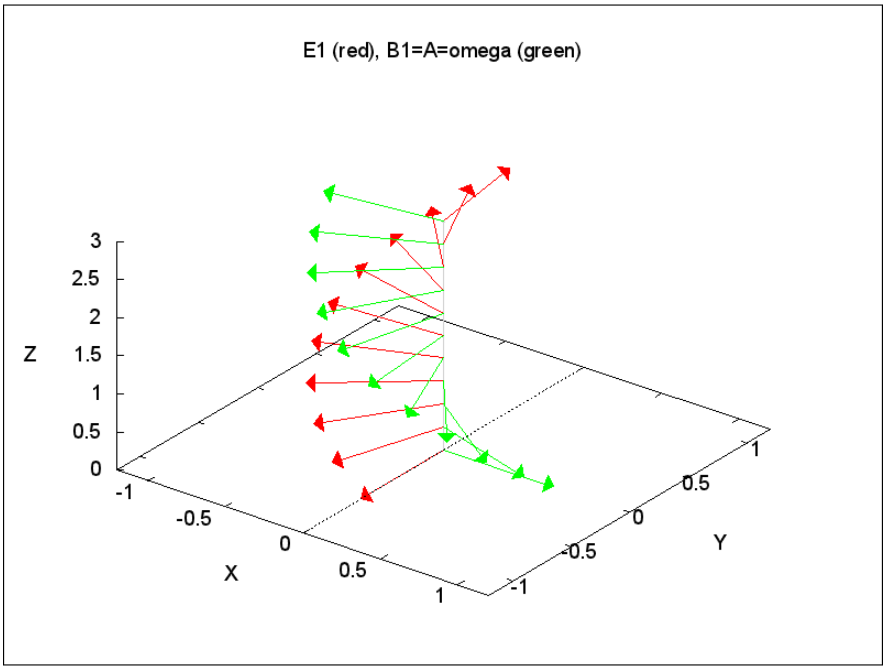

Figure 1: Plane wave, red: $\mathbf{E}_1$ field, green: $\mathbf{A}$, $\mathbf{B}_1$ and $\boldsymbol{\omega}$ fields.

all over the plane but due to the spatial $1/r$ decay the modulus of the vectors decreases with the distance from coordinate origin. The fields $\mathbf{E}_1$, $\mathbf{E}_2$ and $\mathbf{B}_1$ look similar with rotated vector orientation. $\mathbf{E}_1$ and $\mathbf{B}_1$ are perpendicular as for pure plane waves. However the spin connection shows an asymmetry (Fig. 5), whose details depend on the height Z. So spacetime is not symmetric to the physically effective fields here. This structure persists in $\mathbf{B}_2$ because it depends on $\boldsymbol{\omega}$. The field $\mathbf{B}_2$ is graphed in Fig. 6, revealing a kind of rotational structure. The Z component of $\boldsymbol{\omega}$ is mapped in Fig. 7. A two-fold symmetry is visible.

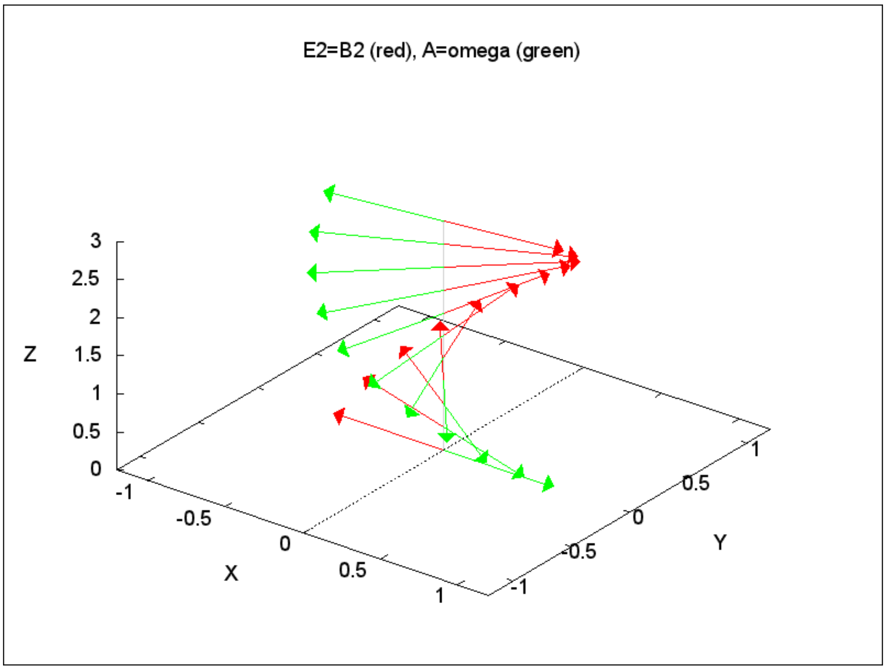

Figure 2: Plane wave, red: $\mathbf{E}_2$ and $\mathbf{B}_2$ field, green: $\mathbf{A}$ field.

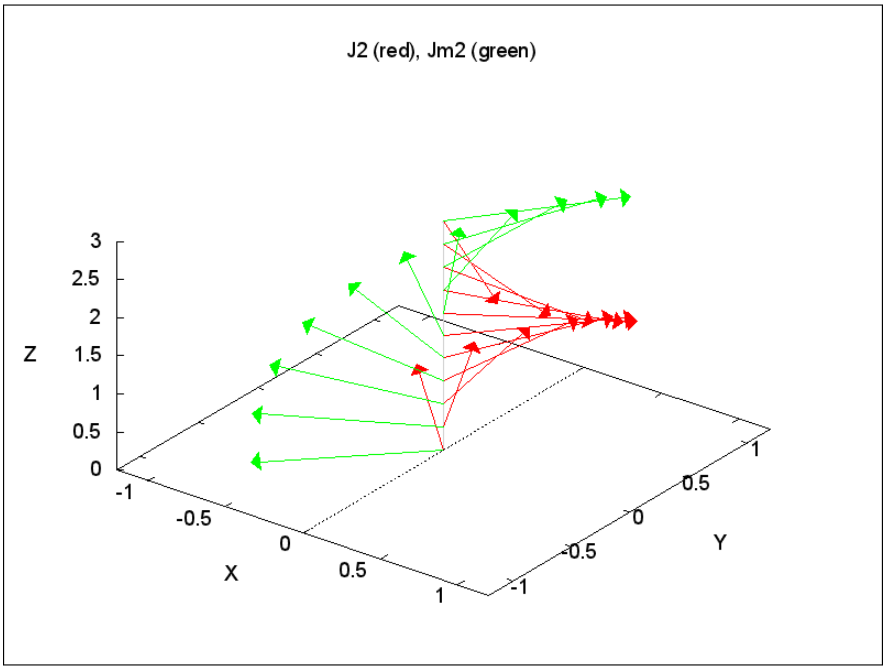

Figure 3: Plane wave, red: electric vacuum current $\mathbf{J}_2$, green: magnetic vacuum current $\mathbf{J}_{m2}$.

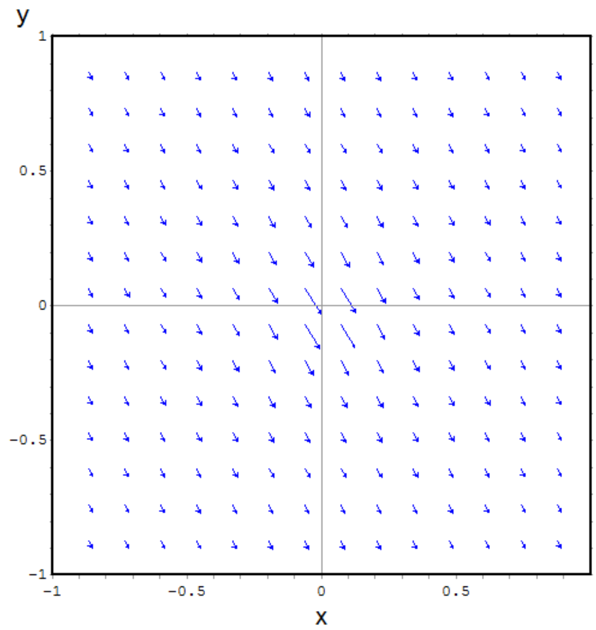

Figure 4: Localized plane wave, **A** field at $Z = 1$.

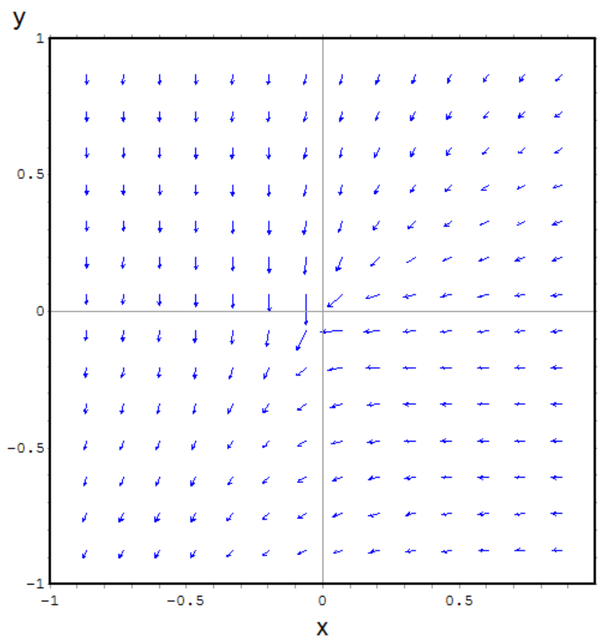

Figure 5: Localized plane wave, $\boldsymbol{\omega}$ field at $Z = 1$.

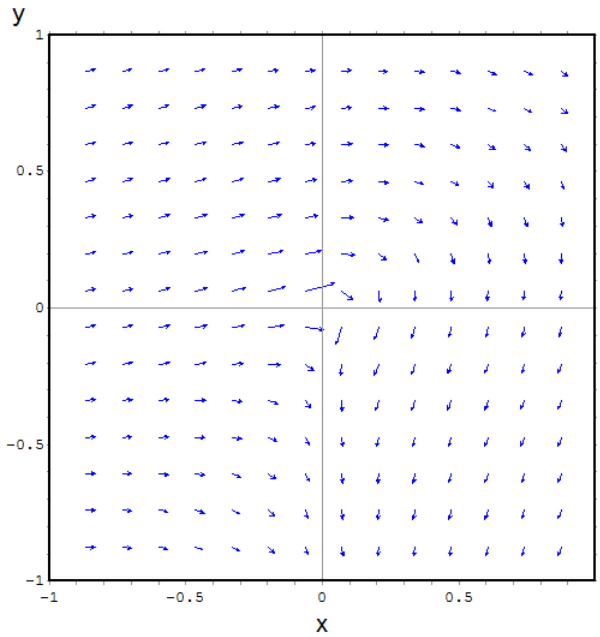

Figure 6: Localized plane wave, $\mathbf{B}_2$ field at $Z = 1$.

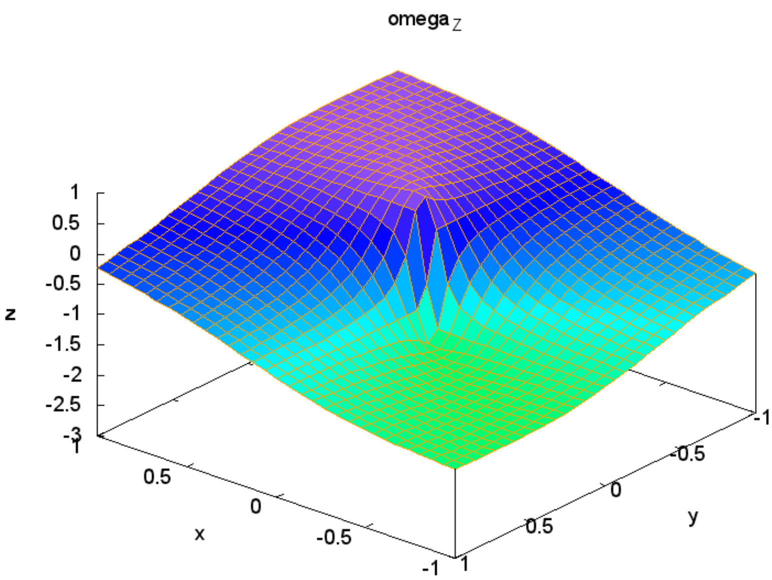

Figure 7: Localized plane wave, map of spin connection component ω_Z at $Z = 1$.

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