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# Basic Definitions and Conventions for Paper 53.

These basic conventions and definitions are needed to reduce the complexity of the tensor and vector equations, in particular to avoid cluttering up the equations with the metric. The convention is needed as soon as the tensor notation is introduced. The basic structure of the resonance equations is encapsulated in the base forms notation:

$$d \wedge F = \mu_0 j, \quad -(1)$$

$$j = \frac{A^{(0)}}{\mu_0} (R \wedge q - \omega \wedge T). \quad -(2)$$

Eq (1) is derived directly from the Cartan structure equations and Bianchi identities, and is the homogeneous ECE field equation. In eqn (1):

$$F = d \wedge A + \omega \wedge A \quad -(3)$$

so from eqn. (3) in eqn (1):

$$\boxed{d \wedge (d \wedge A + \omega \wedge A) = \mu_0 j} \quad -(4)$$

Eq (4) is the "master equation" that gives rise to resonant energy from spacetime and resonant counter gravitation.

## Resonant Energy from Spacetime

Eq (4) is used in reverse, to define the current:

$$j = \frac{1}{\mu_0} (d \wedge (d \wedge A + \omega \wedge A)) \quad -(5)$$

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$$j = \frac{A^{(0)}}{\mu_0} \left( d \wedge \left( d \wedge q + \omega \wedge q \right) \right). \quad -(6)$$

It can be seen that $j$ is pure geometry apart from the factor $A^{(0)} / \mu_0$. The geometry is ECE spacetime, so the current $j$ is obtained from ECE spacetime. Under resonance conditions it is considerably amplified, as observed experimentally by the Mexican Group.

It is also known that:

$$j = \frac{1}{\mu_0} \left( R \wedge A - \omega \wedge F \right) \quad -(7)$$

from eqn. (2). Using eqn. (3) in eqn. (7):

$$j = \frac{1}{\mu_0} \left( R \wedge A - \omega \wedge \left( d \wedge A + \omega \wedge A \right) \right) \quad -(8)$$

Therefore eqn. (4) can be expressed as:

$$\boxed{d \wedge \left( d \wedge A + \omega \wedge A \right) + \omega \wedge \left( d \wedge A \right) + \omega \wedge \left( \omega \wedge A \right) = A^{(0)} R \wedge q} \quad -(9)$$

## Resonance Counter Gravitation

The interaction current is defined as:

$$j_{int} = \frac{A^{(0)}}{\mu_0} R \wedge q \quad -(10)$$

so eqn. (9) is an expression for the interaction current in terms of $A$ and $\omega$:

$$\boxed{j_{int} = \frac{1}{\mu_0}\left(d \wedge (d \wedge A + \omega \wedge A) + \omega \wedge (d \wedge A) + \omega \wedge (\omega \wedge A)\right) \quad -(11)}$$

It can be seen that eqn. (11) is a linear inhomogeneous differential equation, with resonance solutions. At resonance, $j_{int}$ is a maximum. This means that it is possible to produce a curvature form $R$ to oppose the curvature due to the gravity of the Earth, for example. This is done electromagnetically by finding a design to give $A$ and $\omega$ to maximize $R$.

In the standard model there is no interaction between electromagnetism and gravitation, so this type of phenomenon does not exist in the standard model, yet is indicated by ECE field theory.

In the Einstein Hilbert (EH) field theory of pure gravitation:

$$j_{int} = 0 \quad -(12)$$

because

$$R \wedge q = 0. \quad -(13)$$

4) Eq. (13) is the Ricci cyclic equation:

$$R_{\mu\nu\sigma\rho} + R_{\mu\rho\nu\sigma} + R_{\mu\sigma\rho\nu} = 0 \quad -(14)$$

used in the EH field theory of pure gravitation. Without $j_{int}$ however, there is no "driving force" in eqn (11) and no resonance. Electromagnetism cannot affect gravitation in the standard model. Also in the standard model:

$$\omega = 0 \quad -(15)$$

and:

$$d \wedge (d \wedge A) = 0. \quad -(16)$$

In eqn. (11), $d \wedge (d \wedge A)$ plays the role of a "force term"; $d \wedge (\omega \wedge A) + \omega \wedge (d \wedge A)$ plays the role of a "frictional damping term"; and $\omega \wedge (\omega \wedge A)$ plays the role of a "linear restoring force". The current $j_{int}$ is the "driving term". At resonance of amplitude the driving term is maximized. There is a well defined frequency at which this occurs. Therefore at this frequency the interaction current and $R$ are maximized. None of this is possible in eqn. (16) of the standard model.

Therefore in order to describe resonant energy from ECE spacetime and resonant counter gravitation a unified field theory is needed.

5) Summary of Basic Definitions

Flat Spacetime Covariant Derivative

$$\partial_\mu = \left( \frac{1}{c} \frac{\partial}{\partial t}, \underline{\nabla} \right). \quad -(17)$$

Flat Spacetime Contravariant Derivative

$$\partial^\mu = \left( \frac{1}{c} \frac{\partial}{\partial t}, -\underline{\nabla} \right). \quad -(18)$$

$$= \eta^{\mu\nu} \partial_\nu . \quad -(19)$$

Minkowski Metric

$$\eta^{\mu\nu} = \begin{bmatrix} -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} := \mathrm{diag}(-1, 1, 1, 1). \quad -(20)$$

$$= \eta_{\mu\nu}$$

ECE Spacetime Derivatives

$$D^\mu = g^{\mu\nu} D_\nu \quad -(21)$$

where $g^{\mu\nu}$ is the ECE spacetime inverse metric and where $g_{\mu\nu}$ is the ECE spacetime metric:

$$g_{\mu\nu} = \eta_{\mu\nu} + \dots \quad -(22)$$

6)

Note that:

$$g^{\mu\nu} g_{\mu\nu} = 4 \quad - (23)$$

and $g^{\mu\nu} \neq g_{\mu\nu}$ in general in ECE spacetime.

As discussed by Carroll in chapter 3 the derivative operator $\partial_\mu$ in flat spacetime or Minkowski spacetime is a map from $(k, l)$ tensor fields to $(k, l+1)$ tensor fields, acts linearly on its arguments and obeys the Leibnitz theorem for tensor products. The derivative operator $D_\mu$ of ECE spacetime performs the function of $\partial_\mu$ in a way that is independent of coordinates. Since $D_\mu$ obeys the Leibnitz theorem it may always be written as the $\partial_\mu$ operator plus a linear transformation. Thus to construct $D_\mu$ we first apply $\partial_\mu$ and then apply a correction. For a given vector $V^\nu$:

$$D_\mu V^\nu = \partial_\mu V^\nu + \Gamma^\nu_{\mu\lambda} V^\lambda, \quad - (24)$$

where $\Gamma^\nu_{\mu\lambda}$ is the <u>connection</u>. <u>Thus $\partial_\mu$ in ECE spacetime is the same as eqn. (17).</u>

It follows that $\partial^\mu$ in ECE spacetime is the same as eqn. (18), and that the d'Alembertian operator in ECE spacetime is defined as:

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$$\Box = \partial^\mu \partial_\mu = \frac{1}{c^2}\frac{\partial^2}{\partial t^2} - \nabla^2 . \quad -(23)$$

Four Vectors in ECE Spacetime and Minkowski Spacetime

In Minkowski spacetime, a four vector such as $A^\mu$ is defined by:

$$\left.\begin{aligned} A^\mu &= (A^0, \underline{A}) \\ &= (A^0, A^1, A^2, A^3) \\ &= (A^0, A_x, A_y, A_z) \end{aligned}\right\} \quad -(24)$$

Then:

$$\left.\begin{aligned} A_\mu &= (A_0, -\underline{A}) \\ &= (A_0, A_1, A_2, A_3) \\ &= (A_0, -A_x, -A_y, -A_z) \\ &= \eta_{\mu\nu} A^\nu \end{aligned}\right\} \quad -(25)$$

In ECE spacetime the same convention is followed except that $\eta_{\mu\nu}$ is replaced by $g_{\mu\nu}$. Thus:

$$A_\mu = g_{\mu\nu} A^\nu \; ; \; A^\mu = g^{\mu\nu} A_\nu . \quad -(26)$$

8) Therefore to obtain equations which are not cluttered by the metric we either define $A^\mu$ and obtain $A_\mu$ with the metric, or vice-versa. Note that $g_{\mu\nu}$ is the metric and that $g^{\mu\nu}$ is the <u>inverse</u> metric.

Finally when using $\partial_\mu$ or $\partial^\mu$ in ECE spacetime they are defined by:

$$\partial_\mu = \left( \frac{1}{c} \frac{\partial}{\partial t}, \underline{\nabla} \right) \quad -(27)$$
$$= (\partial_0, \partial_1, \partial_2, \partial_3)$$
$$= \left( \frac{1}{c} \frac{\partial}{\partial t}, \frac{\partial}{\partial X}, \frac{\partial}{\partial Y}, \frac{\partial}{\partial Z} \right)$$

and

$$\partial^\mu = \left( \frac{1}{c} \frac{\partial}{\partial t}, -\underline{\nabla} \right) \quad -(28)$$
$$= (\partial^0, \partial^1, \partial^2, \partial^3)$$
$$= \left( \frac{1}{c} \frac{\partial}{\partial t}, -\frac{\partial}{\partial X}, -\frac{\partial}{\partial Y}, -\frac{\partial}{\partial Z} \right).$$

<u>The Spin Connection</u>

The spin connection $\omega_{\mu b}^{a}$ may be defined as a four-vector indexed $\mu$ with additional indices a and b. Thus $\mu$ <u>can</u> is raised or lowered with the metric $g_{\mu\nu}$ or inverse metric $g^{\mu\nu}$:

$$\omega_{\mu b}^{\ a} = g_{\mu\nu}\,\omega^{\nu a}_{\ \ b} \ ; \quad \omega^{\mu a}_{\ \ b} = g^{\mu\nu}\,\omega_{\nu b}^{\ a} . \quad -(29)$$

Note that summation always occurs over repeated raised / lowered indices. This is the Einstein convention.

Thus:

$$\omega_{\mu b}^{\ a} = \left(\omega_{0b}^{\ a}, -\underline{\omega}^{a}_{\ b}\right) \quad -(30)$$

$$\omega^{\mu a}_{\ \ b} = \left(\omega^{0a}_{\ \ b}, \underline{\omega}^{a}_{\ b}\right). \quad -(31)$$

## The Field Tensor

With these definitions and conventions, the field tensor may be defined from eq. (3):

$$F^{\mu\nu a} = \partial^\mu A^{\nu a} - \partial^\nu A^{\mu a} + \omega^{\mu a}_{\ \ b} A^{\nu b} - \omega^{\nu a}_{\ \ b} A^{\mu b}$$

$$= -F^{\nu\mu a} \quad -(32)$$

The convention is adopted of defining $\omega^{\mu a}_{\ \ b}$ as metric free through eqn. (31).

## Electric Field Components

The structure of the field tensor (32) is built up of electric and magnetic field components defined as follows:

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$$F^{\mu\nu} = \begin{bmatrix} 0 & -E^1/c & -E^2/c & -E^3/c \\ E^1/c & 0 & -B^3 & B^2 \\ E^2/c & B^3 & 0 & -B^1 \\ E^3/c & -B^2 & B^1 & 0 \end{bmatrix} \quad -(33)$$

where:

$$\left.\begin{aligned} E^1 &= E_X, \quad E^2 = E_Y, \quad E^3 = E_Z, \\ B^1 &= B_X, \quad B^2 = B_Y, \quad B^3 = B_Z. \end{aligned}\right\} \quad -(34)$$

Thus:

$$F^{01} = -E^1/c, \quad F^{02} = -E^2/c, \quad F^{03} = -E^3/c$$
$$= -F^{10}, \quad = -F^{20}, \quad = -F^{30},$$
$$-(35)$$

and:

$$\left.\begin{aligned} F^{12} &= -F^{21} = -B^3 \\ F^{13} &= -F^{31} = B^2 \\ F^{23} &= -F^{32} = -B^1. \end{aligned}\right] \quad -(36)$$

Therefore:

$$F^{01a} = -\frac{1}{c} E^{1a} = \partial^0 A^{1a} - \partial^1 A^{0a} + \omega^{0a}{}_b A^{1b} - \omega^{1a}{}_b A^{0b}$$

$$= -\frac{1}{c} E^a_X = \frac{1}{c}\frac{\partial A^a_X}{\partial t} + \frac{\partial A^{0a}}{\partial X} + \omega^{0a}{}_b A^b_X - \omega^a{}_{Xb} A^{0b}$$

$$-(37)$$

It follows that:

$$\boxed{\underline{E}^a = -\frac{\partial \underline{A}^a}{\partial t} - c\underline{\nabla} A^{0a} - c\omega^{0a}{}_b \underline{A}^b + c\underline{\omega}^a{}_b A^{0b} \quad -(38)}$$

which is eqn. (52) of paper (52). This is the electric field in ECE theory. In the standard model:

$$\underline{E} = -\frac{\partial \underline{A}}{\partial t} - c\underline{\nabla} A^0 \quad -(39)$$

$$= -\frac{\partial \underline{A}}{\partial t} - \underline{\nabla}\phi$$

where $\underline{A}$ is the vector potential and $\phi$ is the scalar potential.

**Magnetic Field**

We have, for example:

$$F^{12} = -B^3 = -B_Z$$

$$= \partial^1 A^2 - \partial^2 A^1 + \omega^{1a}{}_b A^{2b} - \omega^{2a}{}_b A^{1b},$$

$$-B_Z = -\frac{\partial A_Y}{\partial X} + \frac{\partial A_X}{\partial Y} + \omega_X{}^a{}_b A_Y^b - \omega_Y{}^a{}_b A_X^b.$$

$$-(40)$$

Now use the definition of the vector curl:

$$\underline{\nabla} \times \underline{A} = \begin{vmatrix} \underline{i} & \underline{j} & \underline{k} \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ A_x & A_y & A_z \end{vmatrix} \quad - (41)$$

and vector cross product:

$$\underline{A} \times \underline{B} = \begin{vmatrix} \underline{i} & \underline{j} & \underline{k} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix} \quad - (42)$$

to find that:

$$\boxed{\underline{B}^a = \underline{\nabla} \times \underline{A}^a - \underline{\omega}^a{}_b \times \underline{A}^b} \quad - (43)$$

which is eqn. (55) of paper (52). Eq. (43) defines the magnetic field in ECE field theory.

Summary Box

$$\boxed{\begin{aligned} F &= D \wedge A \\ &= d \wedge A + \omega \wedge A \end{aligned}} \longrightarrow \boxed{\begin{aligned} \underline{E}^a &= -\frac{\partial \underline{A}^a}{\partial t} - c \underline{\nabla} A^{0a} - c\omega^{0a}{}_b \underline{A}^b + c \underline{\omega}^a{}_b A^{0b}, \\ \underline{B}^a &= \underline{\nabla} \times \underline{A}^a - \underline{\omega}^a{}_b \times \underline{A}^b. \end{aligned}}$$

FORM

VECTOR