K

The Four Fundamental Laws of Electrodynamics In The Unified Field Theory: Vector Notation

K.1 The Inhomogeneous Laws

Those are obtained from:

$$\partial_\mu F^{a\mu\nu} = \mu_0 c J^{a\nu} \tag{K.1}$$

where:

$$J^{a\nu} = -\frac{A^{(0)}}{\mu_0}\left(q^b{}_\mu R^a{}_b{}^{\mu\nu} + \omega^a{}_{\mu b} T^{b\mu\nu}\right) \tag{K.2}$$

K.2 Coulomb Law ($\boldsymbol{\nu = 0, \mu = 1, 2, 3}$)

The charge density is:

$$\begin{aligned} J^{a0} = -\frac{A^{(0)}}{\mu_0}(&q^b{}_1 R^a{}_b{}^{10} + q^b{}_2 R^a{}_b{}^{20} + q^b{}_3 R^a{}_b{}^{30} \\ &+ \omega^a{}_{1b} T^{b10} + \omega^a{}_{2b} T^{b20} + \omega^a{}_{3b} T^{b30}) \end{aligned} \tag{K.3}$$

so

$$\boxed{\nabla \cdot \boldsymbol{E}^a = \frac{\rho^a}{\epsilon_0} = \mu_0 c J^{a0}} \tag{K.4}$$

It is seen that charge density originates in the geometry of spacetime. Therefore if gravitation changes spacetime it has an effect on the charge density. This is a direct result of differential geometry.

K.3 Ampère Maxwell law ($\boldsymbol{\nu = 1, 2, 3}$)

For $\boldsymbol{\nu = 1, \mu = 0, 2, 3}$

$$\begin{aligned} J^a{}_x = J^{a1} = -\frac{A^{(0)}}{\mu_0}(&q^b{}_0 R^a{}_b{}^{01} + q^b{}_2 R^a{}_b{}^{21} + q^b{}_3 R^a{}_b{}^{31} \\ &+ \omega^a{}_{0b} T^{b02} + \omega^a{}_{2b} T^{b21} + \omega^a{}_{3b} T^{b31}) \end{aligned} \tag{K.5}$$

For $\nu = 2, \mu = 0, 1, 3$

$$\begin{aligned} J^a{}_y = J^{a2} = -\frac{A^{(0)}}{\mu_0}(&q^b{}_0 R^a{}_b{}^{02} + q^b{}_1 R^a{}_b{}^{12} + q^b{}_3 R^a{}_b{}^{32} \\ &+ \omega^a{}_{0b} T^{b02} + \omega^a{}_{1b} T^{b12} + \omega^a{}_{3b} T^{b32}) \end{aligned} \tag{K.6}$$

For $\nu = 3, \mu = 0, 1, 2$

$$\begin{aligned} J^a{}_z = J^{a3} = -\frac{A^{(0)}}{\mu_0}(&q^b{}_0 R^a{}_b{}^{03} + q^b{}_1 R^a{}_b{}^{13} + q^b{}_2 R^a{}_b{}^{23} \\ &+ \omega^a{}_{0b} T^{b03} + \omega^a{}_{1b} T^{b13} + \omega^a{}_{2b} T^{b23}) \end{aligned} \tag{K.7}$$

Thus:

$$\boxed{\nabla \times \boldsymbol{B}^a = \frac{1}{c^2}\frac{\partial \boldsymbol{E}^a}{\partial t} + \mu_0 \boldsymbol{J}^a} \tag{K.8}$$

in which the scalar elements of current are given in eqns.(K.5) to (K.7).

K.4 The Gauss Law of Magnetism

For all practical purposes:

$$\boxed{\nabla \cdot \boldsymbol{B}^a = 0} \tag{K.9}$$

K.5 The Faraday Law of Induction

For all practical purposes:

$$\boxed{\nabla \times \boldsymbol{E}^a + \frac{\partial \boldsymbol{B}^a}{\partial t} = \boldsymbol{0}} \tag{K.10}$$

If we take into consideration the very tiny homogeneous current then:

$$\begin{aligned} j^{a\nu} &= -\frac{A^{(0)}}{\mu_0}\left(q^b{}_\mu \widetilde{R}^a{}_b{}^{\mu\nu} + \omega^a{}_{\mu b}\widetilde{T}^{b\mu\nu}\right) \\ &\sim 0 \end{aligned} \tag{K.11}$$

and very tiny terms appear on the right hand sides of eqns. (K.9) and (K.10).

K.6 Simplification Of The IE

An important simplification of the structure of the IE is possible as follows.

In free space, it is known that:

$$d \wedge F^a = 0 \tag{K.12}$$

$$d \wedge \widetilde{F}^a = 0 \tag{K.13}$$

and so:

$$R^a{}_b \wedge q^b = \omega^a{}_b \wedge T^b \tag{K.14}$$

$$\widetilde{R}^a{}_b \wedge q^b = \omega^a{}_b \wedge \widetilde{T}^b \tag{K.15}$$

The free space condition means that:

$$\omega^a{}_b = -\kappa \epsilon^a{}_{bc} q^c \tag{K.16}$$

$$R^a{}_b = -\kappa \epsilon^a{}_{bc} T^c \tag{K.17}$$

The IE describes **field-matter interaction** as follows:

$$\begin{aligned} d \wedge \widetilde{F}^a &= A^{(0)} \left(\widetilde{R}^a{}_b \wedge q^b - \omega^a{}_b \wedge \widetilde{T}^b \right) \\ &\neq 0. \end{aligned} \tag{K.18}$$

Comparison of eqn. (K.15) and (K.18) means that the pressence of mass changes the equality (K.15). The reason for this is **gravitation**, i.e. the presence of mass.

For Einsteinian or Newtonian gravitation:

$$R^a{}_b \wedge q^b = 0 \tag{K.19}$$

but:

$$\left(\widetilde{R}^a{}_b \wedge q^b \right)_{grav.} \neq 0. \tag{K.20}$$

However, for electromagnetism:

$$\left(\widetilde{R}^a{}_b \wedge q^b - \omega^a{}_b \wedge \widetilde{T}^b \right)_{e/m} = 0. \tag{K.21}$$

Therefore the IE simplifies to:

$$\boxed{d \wedge \widetilde{F}^a = A^{(0)} \left(\widetilde{R}^a{}_b \wedge q^b \right)_{grav}} \tag{K.22}$$

and:

$$J^a = \frac{A^{(0)}}{\mu_0} \left(\widetilde{R}^a{}_b \wedge q^b \right)_{grav.} \tag{K.23}$$

In the weak field limit eqn. (K.23) means that he Coulomb and Newton inverse square laws have the same distance dependence, as known experimentally.

APART FROM THE $A^{(0)}$ FACTOR J^a ORIGINATES ENTIRELY IN CENTRALLY DIRECTED GRAVITATION.

K.7 Derivation of The Coulomb Law From The Evans Unified Field Theory

The Coulomb Law is derived from the inhomogeneous Evans field equation (barebones notation):

$$\begin{aligned} d \wedge \widetilde{F} &= A^{(0)}(\widetilde{R} \wedge q - \omega \wedge \widetilde{T}) \\ &= -A^{(0)}(q \wedge \widetilde{R} + \omega \wedge \widetilde{T}). \end{aligned} \tag{K.24}$$

For electromagnetic radiation in free space:

$$q \wedge \widetilde{R} + \omega \wedge \widetilde{T} = 0. \tag{K.25}$$

It is assumed that condition (K.25) continues to be true in field-matter interaction. (This is equivalent to the standard **minimal prescription** where p^μ is replaced by $p^\mu + eA^\mu$.)

For central gravitation (Einstein/Newton):

$$T = 0 \tag{K.26}$$

$$R \wedge q = 0 \tag{K.27}$$

$$\widetilde{R} \wedge q \neq 0. \tag{K.28}$$

Therefore from eqns. (K.25) to (K.28):

$$\boxed{d \wedge \widetilde{F} = -A^{(0)}(\widetilde{R} \wedge q)_{grav}} \tag{K.29}$$

This is the inhomogeneous field equation linking electromagnetism to gravitation. Any type of electromagnetic field matter interaction is described by eqn. (K.29) provided eqn. (K.25) remains true for the electromagnetic field when the latter interacts with matter.

K.7.1 Tensor Notation

Eqn. (K.29) is:

$$\partial_\mu \widetilde{F}^a{}_{\nu\rho} + \partial_\rho \widetilde{F}^a{}_{\mu\nu} + \partial_\nu \widetilde{F}^a{}_{\rho\mu} = -A^{(0)}(q^b{}_\mu \widetilde{R}^a{}_{b\nu\rho} + q^b{}_\rho \widetilde{R}^a{}_{b\mu\nu} + q^b{}_\nu \widetilde{R}^a{}_{b\rho\mu}) \tag{K.30}$$

which is the same equation as:

$$\partial_\mu F^{a\mu\nu} = -A^{(0)} q^b{}_\mu R^a{}_b{}^{\mu\nu} \tag{K.31}$$

$$\boxed{\partial_\mu F^{a\mu\nu} = -A^{(0)} R^a{}_\mu{}^{\mu\nu}} \tag{K.32}$$

using:

$$R^a{}_{\lambda\nu\mu} = q^b{}_\lambda R^a{}_{b\nu\mu}. \tag{K.33}$$

Eqn.(K.32) is the simplest tensor formulation of the inhomogeneous Evans field equation.

K.7.2 Vector Notation

In vector notation eqn (K.32) gives the Coulomb Law and the Ampère-Maxwell Law.

Coulomb Law (ν=0, μ=1,2,3)

$$\begin{aligned}\partial_1 F^{a10} + \partial_2 F^{a20} + \partial_3 F^{a30} &= -A^{(0)}({R^a}_1{}^{10} + {R^a}_2{}^{20} + {R^a}_3{}^{30}) \\ &= -A^{(0)} {R^a}_i{}^{i0}\end{aligned} \tag{K.34}$$

where summation over repeated i is implied. Now denote **the fundamental voltage**, $\phi^{(0)}$ by:

$$\phi^{(0)} = cA^{(0)} \tag{K.35}$$

to obtain:

$$\nabla \cdot \boldsymbol{E}^a = -cA^{(0)} {R^a}_i{}^{i0} \tag{K.36}$$

i.e.

$$\boxed{\nabla \cdot \boldsymbol{E}^a = -\phi^{(0)} {R^a}_i{}^{i0}} \tag{K.37}$$

and

$$\boxed{\rho^a = -\epsilon_0 \phi^{(0)} {R^a}_i{}^{i0}}. \tag{K.38}$$

Eqn. (K.37) is the Coulomb Law unified with the Newton inverse square law.

Notes.

The units on both sides of eqn. (K.37) are volt/m squared and it is seen in eqn (K.38) that charge density originates in ${R^a}_i{}^{i0}$, **the sum of three Riemann curvature elements.** These elements describe gravitation in the Einstein theory of general relativity. The elements are therefore governed by theEinstein field equation. In the weak field limit this becomes **the Newton inverse square law**.

Given the existence of $\phi^{(0)}$ it is seen from eqn. (K.37) and (K.38) that **an electric field can be generated by gravitation**.

Ampère-Maxwell Law (ν=1,2,3)

This is given by:

$$\boxed{\nabla \times \boldsymbol{B}^a = \frac{1}{c^2}\frac{\partial \boldsymbol{E}^a}{\partial t} + \mu_0 \boldsymbol{J}^a} \tag{K.39}$$

where:

$$\boldsymbol{J}^a = J^a_x \boldsymbol{i} + J^a_y \boldsymbol{j} + J^a_z \boldsymbol{k} \tag{K.40}$$

and:

$$J^a{}_x = -\frac{A^{(0)}}{\mu_0}\left(R^a{}_0{}^{10} + R^a{}_2{}^{12} + R^a{}_3{}^{13}\right) \tag{K.41}$$

$$J^a{}_y = -\frac{A^{(0)}}{\mu_0}\left(R^a{}_0{}^{20} + R^a{}_1{}^{21} + R^a{}_3{}^{23}\right) \tag{K.42}$$

$$J^a{}_z = -\frac{A^{(0)}}{\mu_0}\left(R^a{}_0{}^{30} + R^a{}_1{}^{31} + R^a{}_2{}^{32}\right). \tag{K.43}$$

From eqns. (K.40) to (K.43) it is seen that **current density originates in sums over Riemann tensor elements.**

This finding has the important consequence that electric current can be generated by spacetime curvature. The relevant Riemann tensor elements are again calculated from the Einstein field equation for gravitation.