352(b): Conventional Electrodynamics in terms of the ECE2 Potentials.

In ECE2 the electric and magnetic fields are defined as:

$$\underline{B} = \underline{\nabla} \times \underline{W} \quad -(1)$$

and

$$\underline{E} = -\frac{\partial \underline{W}}{\partial t} - \underline{\nabla} \phi_W \quad -(2)$$

so the homogeneous field equations become identities:

$$\underline{\nabla} \cdot \underline{B} = \underline{\nabla} \cdot \underline{\nabla} \times \underline{W} = 0 \quad -(3)$$

and

$$\underline{\nabla} \times \underline{E} + \frac{\partial \underline{B}}{\partial t} = \underline{0} \quad -(4)$$

$$= \underline{\nabla} \times \left(-\frac{\partial \underline{W}}{\partial t} - \underline{\nabla} \phi_W \right) + \frac{\partial}{\partial t} \left(\underline{\nabla} \times \underline{W} \right) = \underline{0}$$

$$= -\frac{\partial}{\partial t} \left(\underline{\nabla} \times \underline{W} \right) + \frac{\partial}{\partial t} \left(\underline{\nabla} \times \underline{W} \right) - \underline{\nabla} \times \underline{\nabla} \phi_W$$

The inhomogeneous field equations are:

$$\underline{\nabla} \cdot \underline{E} = \rho / \epsilon_0 \quad -(5)$$

and

$$\underline{\nabla} \times \underline{B} - \frac{1}{c^2} \frac{\partial \underline{E}}{\partial t} = \mu_0 \underline{J} \quad -(6)$$

The Coulomb law (5) transforms into:

$$\nabla^2 \phi_W = -\frac{\rho}{\epsilon_0} - \frac{\partial}{\partial t} \left(\underline{\nabla} \cdot \underline{W} \right) \quad -(7)$$

i.e.

$$\boxed{\nabla^2 \phi_W + \frac{\partial}{\partial t} \left(\underline{\nabla} \cdot \underline{W} \right) = -\rho / \epsilon_0} \quad -(8)$$

which is a second order wave equation in the potential ϕ_W, and the vector potential $\underline{W}$.

2) Eq. (8) can be considered as the equation of a circuit in contact with the vacuum charge density $\rho(\text{vac})$.

So:

$$\left(\nabla^2 \phi_W + \frac{\partial}{\partial t}\left(\underline{\nabla} \cdot \underline{W}\right)\right)_{\text{circuit}} = -\frac{\rho(\text{vac})}{\epsilon_0} \quad -(9)$$

Here:

$$\rho(\text{vac}) = \epsilon_0 \left(\frac{\rho_m}{\rho}\right)_{\text{vac}} q_F \quad -(10)$$

where ρ_m is the mass density of the vacuum or spacetime, and $\rho(\text{vac})$ is the charge density of the vacuum. The vacuum is more accurately described as "the aether".

In Eq. (10), q_F is the Kambe charge defined by:

$$q_F = \underline{\nabla} \cdot \left(\left(\underline{v} \cdot \underline{\nabla}\right) \underline{v}\right) \quad -(11)$$

where

$$\underline{v} = v(\underline{r}(t), t) \quad -(12)$$

is the velocity field of the fluid aether. So the quantity on the left hand side of eq. (9) can be computed directly from eqs. (10) and (11) given a parameterization of $(\rho_m / \rho)(\text{vacuum})$. Transition to turbulence in q_F is governed by:

$$\frac{\partial \underline{v}}{\partial t} + \underline{W} \times \underline{v} = -\frac{1}{R} \underline{\nabla} \times \underline{W} \quad -(13)$$

) where

$$\underline{W} = \underline{\nabla} \times \underline{V} \quad -(14)$$

Similarly, the Ampère Maxwell law can be expressed as:

$$\underline{\nabla} \times (\underline{\nabla} \times \underline{W}) - \frac{1}{c^2}\frac{\partial}{\partial t}\left(-\frac{\partial \underline{W}}{\partial t} - \underline{\nabla}\phi_W\right) = \mu_0 \underline{J}$$

$$= -\nabla^2 \underline{W} + \underline{\nabla}(\underline{\nabla} \cdot \underline{W}) + \frac{1}{c^2}\frac{\partial^2 \underline{W}}{\partial t^2} + \frac{1}{c^2}\underline{\nabla}\phi_W \quad -(15)$$

So

$$\left(\frac{1}{c^2}\frac{\partial^2}{\partial t^2} - \nabla^2\right)\underline{W} + \underline{\nabla}(\underline{\nabla} \cdot \underline{W}) + \frac{1}{c^2}\frac{\partial}{\partial t}(\underline{\nabla}\phi_W)$$

$$= \mu_0 \underline{J} \quad -(16)$$

In the usual electrodynamics it is assumed that:

$$\partial_\mu W^\mu = 0 \quad -(17)$$

so

$$\frac{1}{c^2}\frac{\partial \phi_W}{\partial t} + \underline{\nabla} \cdot \underline{W} = 0 \quad -(18)$$

so eq. (16) reduces to:

$$\boxed{\Box \underline{W} = \mu_0 \underline{J}} \quad -(19)$$

here

$$\Box = \frac{1}{c^2}\frac{\partial^2}{\partial t^2} - \nabla^2 \quad -(20)$$

the d'Alembertian.

Using the same condition (18) in eq. (8)

) gives $$\boxed{\Box \phi_W = \frac{\rho}{\epsilon_0}} \quad -(21)$$

In the above: $$\partial_\mu = \left(\frac{1}{c}\frac{\partial}{\partial t}, \underline{\nabla} \right) \quad -(22)$$

and $$W^\mu = \left(\frac{\phi_W}{c}, \underline{W} \right). \quad -(23)$$

Defining: $$J^\mu = (c\rho, \underline{J}) \quad -(24)$$

it follows that: $$\boxed{\Box W^\mu = \mu_0 J^\mu} \quad -(25).$$

provided that $$\partial_\mu W^\mu = 0 \quad -(26)$$

If eq. (26) is not assumed, then:
$$\nabla^2 \phi_W + \frac{\partial}{\partial t}\left(\underline{\nabla} \cdot \underline{W} \right) = -\frac{\rho}{\epsilon_0} \quad -(27)$$

and

$$\Box \underline{W} + \underline{\nabla}\left(\underline{\nabla} \cdot \underline{W} \right) + \frac{1}{c^2}\frac{\partial}{\partial t}\left(\underline{\nabla} \phi_W \right) = \mu_0 \underline{J} \quad -(28)$$

For a circuit in contact with the vacuum:

$$\left(\square \underline{W} + \underline{\nabla}\left(\underline{\nabla}\cdot\underline{W} + \frac{1}{c^2}\frac{\partial \phi_W}{\partial t}\right)\right)_{circuit} = \mu_0 \underline{J}(vac) \quad -(29)$$

in which:

$$\underline{J}(vac) = \epsilon_0 \left(\frac{\rho_m}{\rho}\underline{J}_F\right)_{vac} \quad -(30)$$

In general, the Kambe current is:

$$\underline{J}_F = -\frac{\partial}{\partial t}\left((\underline{v}\cdot\underline{\nabla})\underline{v}\right) + a_0^2\,\underline{\nabla}\times(\underline{\nabla}\times\underline{v}) \quad -(31)$$

Both q_F and $\underline{J}_F$ are defined entirely in terms of the velocity field $\underline{v}(\underline{r}(t), t)$ of the aether.

The next note will express equations (25) and a combination of eqs. (27) and (28), in terms of the ECE wave equation:

$$(\square + R)W^\mu = 0 \quad -(32)$$