Note 389(8): Suggested Standard Procedure

First note that the d'Alembert equation is obtained from the wave equation of ECE theory:

$$\Box A^\mu = \mu_0 J^\mu = -A^{(0)} R q^\mu = -R A^\mu \quad -(1)$$

for each a. So:

$$\Box \phi = \rho / \epsilon_0 \quad -(2)$$

and

$$\Box \underline{A} = \mu_0 \underline{J} \quad -(3)$$

in which ρ and $\underline{J}$ are linked by the continuity equation

$$\frac{\partial \rho}{\partial t} + \underline{\nabla} \cdot \underline{J} = 0. \quad -(4)$$

Therefore in ECE2 physics, the well known eqs (2) and (3) are obtained without having to assume the Lorenz condition.

From the ECE2 Coulomb law:

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

where

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

From eqs. (2) and (5):

$$\underline{\nabla} \cdot \underline{E} = \Box \phi \quad -(7)$$

i.e.

$$-\nabla^2 \phi + \underline{\nabla} \cdot (\underline{\omega} \phi) = \Box \phi \quad -(8)$$

$$= \left(\frac{1}{c^2} \frac{\partial^2}{\partial t^2} - \nabla^2 \right) \phi$$

It follows that

$$\boxed{\frac{\partial^2 \phi}{\partial t^2} = \underline{\nabla} \cdot (\underline{\omega} \phi) = \phi \underline{\nabla} \cdot \underline{\omega} + \underline{\omega} \cdot \underline{\nabla} \phi} \quad -(9)$$

Suggested Standard Procedure

measure the charge density in a material or in a circuit.

1) Find ϕ from:

$$\phi(\underline{x}) = \frac{1}{4\pi\epsilon_0}\int \frac{\rho(\underline{x}')}{|\underline{x}-\underline{x}'|}\, d^3x' \quad -(10)$$

2) Find $\underline{\omega}$ from eq. (9).

3) Find $\underline{E}$ from:

$$\underline{E} = -\underline{\nabla}\phi + \underline{\omega}\phi := -\underline{\nabla}\phi - \frac{\partial A}{\partial t}(\text{total}) \quad -(11)$$

5) Find $\underline{B}$ from:

$$\underline{B} = \underline{\nabla}\times\underline{A} - \underline{\omega}\times\underline{A} := \underline{\nabla}\times\underline{A}(\text{total}) \quad -(12)$$

Find $\underline{A}(\text{total})$ from:

$$\frac{\partial \underline{A}(\text{total})}{\partial t} = -\underline{\omega}\phi \quad -(13)$$

where

$$\underline{A}(\text{total}) = \underline{A} + \underline{A}_1 \quad -(14)$$

and

$$\underline{\nabla}\times\underline{A}_1 = -\underline{\omega}\times\underline{A} \quad -(15)$$

7) Find $\underline{A}$ from the vector antisymmetry conservation conditions, given $\underline{\omega}$:

$$\frac{\partial A_z}{\partial y} + \frac{\partial A_y}{\partial z} = \omega_y A_z + \omega_z A_y \quad -(16)$$

$$\frac{\partial A_x}{\partial z} + \frac{\partial A_z}{\partial x} = \omega_z A_x + \omega_x A_z \quad -(17)$$

$$\frac{\partial A_y}{\partial x} + \frac{\partial A_x}{\partial y} = \omega_x A_y + \omega_y A_x \quad -(18)$$

8) Find $\underline{A_1}$ from:

$$\underline{A_1} = \underline{A}(\text{total}) - \underline{A} \quad -(19)$$

9) Check for self consistency using the trace corresponding equation or Lindstrom constraint:

$$\frac{1}{c^2}\left(\frac{\partial}{\partial t} + \omega_0\right)\phi = (\underline{\nabla} - \underline{\omega})\cdot\underline{A} \quad -(20)$$

Firstly, find ω_0 from eq. (20)

$$\omega_0 = \frac{1}{\phi}\left[c^2(\underline{\nabla} - \underline{\omega})\cdot\underline{A} - \frac{\partial\phi}{\partial t}\right] \quad -(21)$$

Then use:

$$\underline{E} = -\underline{\nabla}\phi + \underline{\omega}\phi = -\frac{\partial\underline{A}}{\partial t} - \frac{1}{\phi}\left(c^2(\underline{\nabla} - \underline{\omega})\cdot\underline{A} - \frac{\partial\phi}{\partial t}\right)\underline{A} \quad -(22)$$

10) If necessary, regauge to obey eq. (22):

$$\phi \longrightarrow \phi + \frac{\partial\psi}{\partial t} \quad -(23)$$

$$\underline{A}(\text{total}) \rightarrow \underline{A}(\text{total}) - \underline{\nabla}\psi \quad -(24)$$

and find the gauge functions $\partial\psi/\partial t$ and $\underline{\nabla}\psi$.

This procedure obeys all five corresponding equations simultaneously, eqs. (6), (16) to (18), and (20). It is suggested that it be used for all situations in physics.