1)

Notes for Paper 54

Phase Velocity in ECE Theory

As a simple illustration of phase velocity, consider the Lorentzian ECE field equation:

$$\underline{\nabla} \times \underline{E}^{(a)} + \frac{\partial \underline{B}^{(a)}}{\partial t} = \mu_0 \underline{\tilde{J}}^{(a)} \quad - (1)$$

This can be expressed as:

$$\underline{\nabla} \times \left(\epsilon_r \underline{E}^{(a)} \right) + \frac{\partial}{\partial t} \left(\frac{1}{\mu_r} \underline{B}^{(a)} \right) = \underline{0} \quad - (2)$$

Here $\underline{E}^{(a)}$ is electric field strength (volt m^{-1}), $\underline{B}^{(a)}$ is magnetic flux density (tesla), μ_0 is the vacuum permeability and $\underline{\tilde{J}}^{(a)}$ the Lorentzian current. In eqn (2):

$$\mu_r = \mu / \mu_0, \quad \epsilon_r = \epsilon / \epsilon_0, \quad - (3)$$

where μ_r is the relative permeability of ECE spacetime, μ is the absolute permeability, ϵ_r is the relative permittivity and ϵ the absolute permittivity, ϵ_0 being the vacuum permittivity.

The refractive index of ECE spacetime is:

$$n^2 = \mu_r \epsilon_r \quad - (4)$$

2)

The phase velocity of a wave in ECE spectra is defined as:

$$v = \frac{c}{n^2} = \frac{c}{\mu_r \epsilon_r} \quad -(5)$$

The relative permeability and permittivity are complex quantities in general:

$$\mu_r = \mu_r' + i\mu_r'' \quad -(6)$$

$$\epsilon_r = \epsilon_r' + i\epsilon_r'', \quad -(7)$$

So

$$v = \frac{c}{(\mu_r' + i\mu_r'')(\epsilon_r' + i\epsilon_r'')} \quad -(8)$$

$$= \frac{c}{x + iy} \quad -(9)$$

where:

$$x = \mu_r' \epsilon_r' - \mu_r'' \epsilon_r'', \quad -(10)$$

$$y = \mu_r' \epsilon_r'' + \mu_r'' \epsilon_r'. \quad -(11)$$

So the real-valued and physical part of the phase velocity is:

$$\boxed{Re(v) = \frac{x}{(x^2 - y^2)} c} \quad -(12)$$

3) It is seen that for finite, constant c:

$$Re(v) \to \infty \qquad -(13)$$

when: $$x^2 = y^2, \quad x = \pm y \qquad -(14)$$

If $x = y$:

$$\mu_r' \epsilon_r' - \mu_r'' \epsilon_r'' = \mu_r' \epsilon_r'' + \mu_r'' \epsilon_r' \qquad -(15)$$

If $x = -y$:

$$\mu_r' \epsilon_r' - \mu_r'' \epsilon_r'' = -(\mu_r' \epsilon_r'' + \mu_r'' \epsilon_r') \qquad -(16)$$

The phase velocity v is part of the unified field. Under well defined conditions electromagnetism and gravitation become independent. More generally they are parts of the ECE unified field. Quantum mechanics is also unified, via the ECE wave equation:

$$(\Box + kT) A_\mu^a = 0 \qquad -(17)$$

so the phase velocity of a wave-function may become infinite for finite, constant c, thereby remaining causal and objective.
