1) # Notes for Paper 49, Part Two

Relation between Luminosity, red shift and Refractive Index.

Luminosity in astronomy is defined in watts, the rate at which energy of all types is radiated ______ in all directions, i.e. the area integral of power density I. Luminosity in physics is defined as the density of luminous intensity in a given direction, i.e. watts $/ m^2 /$ steradian $= I /$ steradian. The most meaningful way to relate I to n is to use the Beer Lambert law:

$$I = I_0 \exp(-\alpha Z) \quad -(1)$$

where α is the power absorption coefficient and Z the sample length. I_0 is the power density before entering the sample, and I is the power density at ~~the~~ detector. The power absorption coefficient defined as:

$$\alpha(\omega) = \frac{\omega \epsilon_r''(\omega)}{n'(\omega) c} \quad -(2)$$

where $\epsilon''(\omega)$ is the dielectric loss, ω the angular frequency, $n'(\omega)$ the real part of the frequency dependent refractive index, and c is the speed of light in vacuo. The refractive index is defined as:

$$n^2 = \epsilon_r \mu_r = \frac{\epsilon \mu}{\epsilon_0 \mu_0} \quad -(3)$$

where

$$\epsilon_r = \epsilon / \epsilon_0 \quad -(4)$$

and

$$\mu_r = \mu / \mu_0 . \quad -(5)$$

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Here ϵ_r is the relative permittivity and μ_r is the relative permeability; ϵ is the absolute permittivity and μ is the absolute permeability; ϵ_0 is the vacuum permittivity and μ_0 is the vacuum permeability.

In the presence of absorption:

$$n(\omega) = n'(\omega) + i n''(\omega) \quad -(6)$$

and

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

$$\mu_r(\omega) = \mu_r'(\omega) + i \mu_r''(\omega). \quad -(8)$$

From ECE field theory the equation that defines the interaction of light with gravitation is:

$$\boxed{\underline{\nabla} \times (\epsilon_r \underline{E}^a) + \frac{\partial}{\partial t}\left(\frac{\underline{B}^a}{\mu_r}\right) = \underline{0},} \quad -(9)$$

where $\underline{E}^a$ and $\underline{B}^a$ are respectively the electric field strength and magnetic flux density of the light beam (or electromagnetic wave). Eq. (9) applies to ϵ_r and μ_r which may be functions of (ct, x, y, Z) in general. If the red shift is defined as a shift in angular frequency ω, then it is given from a particular solution of eq. (9) as:

$$\boxed{\omega \rightarrow \omega / \mu_r}. \quad -(10)$$

Other analytical solutions of eq. (9) may exist, giving expressions in general for $\underline{E}^a$ and $\underline{B}^a$.

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The power density I (watts m^{-2}) of the light beam is defined as:

$$\boxed{I = c\epsilon_r E^{a2} + \frac{c}{\mu_r} B^{a2}} \quad -(11)$$

and for a beam of area one square metre this is also the astronomical luminosity. Check the S.I. units of eqn (11):

$$I_1 = c\epsilon_r E^2, \quad I_2 = cB^2/\mu_r, \quad -(12)$$

where:

$$E = Vm^{-1} = JC^{-1}m^{-1} \quad -(13)$$

$$B = JsC^{-1}m^{-2} = \text{Tesla} \quad -(14)$$

$$\epsilon_r = J^{-1}C^2m^{-1}, \; \mu_r = Js^2C^{-2}m^{-1}. \quad -(15)$$

$$I_1 = J^{-1}C^2m^{-1}J^2C^{-2}m^{-2}ms^{-1}$$

$$= Js^{-1}m^{-2} = Wm^{-2} \; \checkmark\checkmark \quad -(16)$$

$$I_2 = ms^{-1}J^2s^2C^{-2}m^{-4}J^{-1}s^{-2}C^2m$$

$$= Js^{-1}m^{-2} = Wm^{-2} \; \checkmark\checkmark \quad -(17)$$

Therefore:

$$\text{Astronomical luminosity} = \int I \, dA \quad -(18)$$

$$\text{Physics luminosity} = I/\Omega \quad -(19)$$

where Ω = solid angle in steradians.

From eq. (11) it is seen that the luminosity of a star or galaxy is determined by the interaction of light with gravitation

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Therefore from eqs (1) and (11)

$$\boxed{I = I_0 e^{-\alpha Z} = c\left(\epsilon_r E^{a2} + \frac{1}{\mu_r} B^{a2}\right)} \quad -(20)$$

Using eqs (9) and (20) it is seen that the power absorption coefficient $\alpha(\omega)$ is a function of the refractive index n of EEC spacetime. The power density at the telescope, I, is also a function of Z and the initial power density I_0 at the source (a star or galaxy etc.).

On the journey of millions of light years between the source and telescope the light is in general absorbed and affected by ϵ_r and μ_r, i.e. by the interaction of light with gravitation. The distance between source and observer is Z.

If there were no absorption then:

$$\alpha = 0 \quad -(21)$$

and:

$$I = I_0 = c\left(\epsilon_0 E^{a2} + \frac{1}{\mu_0} B^{a2}\right) \quad -(22)$$

where ϵ_0 and μ_0 indicate that the light has travelled through a vacuum, in which there is no effect of gravitation on the light. Alternatively, if there is no absorption, the light has travelled through an ECE spacetime where ϵ_r and μ_r are <u>real</u> quantities. In this case <u>diffraction</u> has occurred

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without absorption. This may be the case in an Eddington experiment, and is analogous to the bending of light by glass in a lens or prism.

If absorption occurs, ϵ_r and μ_r are <u>complex</u> quantities.

We now consider a refractive index defined by $\epsilon_r \sim 1$, but complex μ_r:

$$n^2 = \mu_r \qquad -(23)$$

because eq. (11) indicates that the red shift is defined by μ_r, the relative permeability for a given relative permittivity. This seems to be an important finding because it indicates that red shifts are determined by rotational motion as well as by translational or central motion.

Using:

$$n = n' + in'', \qquad -(24)$$

$$\mu_r = \mu_r' + i\mu_r'' \qquad -(25)$$

in eqn (23) it is found that:

$$\boxed{n'(\omega) = \frac{1}{\sqrt{2}}\left(\mu_r' + \left(\mu_r'^2 + \mu_r''^2\right)^{1/2}\right)^{1/2}} \qquad -(26)$$

If:

$$\mu_r'' << \mu_r' \qquad -(27)$$

then:

$$n'(\omega) = \sqrt{\mu_r'(\omega)}. \qquad -(28)$$

5) Finally define the power absorption coefficient as:

$$\alpha(\omega) = \frac{\omega \mu_r''(\omega)}{n'(\omega) c}, \quad -(29)$$

$$-(30)$$

$$\boxed{\alpha(\omega) = \frac{\sqrt{2}\, \omega \mu_r''(\omega)}{c\left(\mu_r' + \left(\mu_r'^2 + \mu_r''^2\right)^{1/2}\right)^{1/2}}}$$

From eqs. (10), (20) and (30) it is seen that the red shift, luminosity and permeability of ECE spacetime are inter-related. ~~Except~~

Relation between Luminosity and Distance Z.

This is given by the Beer Lambert law:

$$I = I_0 e^{-\alpha Z} \quad -(31)$$

so to estimate the distance Z a theoretical model for $\alpha(\omega)$ is needed. The power absorption coefficient is the Fourier transform of a correlation function. In the permeability model leading to eqn. (30) the relevant correlation function is:

$$c(t) = \langle \underline{m}(t) \cdot \underline{m}(0) \rangle \quad -(32)$$

where $\underline{m}$ is the magnetic dipole moment, closely related to angular momentum $\underline{J}$.

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This analysis changes the basis of present day cosmology from the EH to ECE field theory. In EH theory angular momentum is not considered. The basis of Big Bang is EH theory, in which only central forces such as gravitation are considered. Therefore Big Bang can only explain red shifts through translational motion. ECE theory explains red shifts in terms of spectra and can also consider rotational motion.

Therefore to try to model the universe in terms purely of translational motion is much too simple or restrictive, and is based on an EH theory that is incomplete. The completed theory is ECE theory.