291(3): The Effect of $\underline{B}^{(3)}$ on the Rayleigh Jeans Density of States.

The $\underline{B}^{(3)}$ field exists only in radiation which is fully or partially circularly polarized. It generates the energy density:

$$\frac{En}{V} = \frac{1}{\mu_0} \underline{B}^{(3)} \cdot \underline{B}^{(3)*} \quad -(1)$$

where μ_0 is the vacuum permeability. In deriving the result:

$$\frac{dN}{V} = \frac{\omega^2}{\pi^2 c^3} d\omega + \frac{\omega}{\pi^2 c^3} (d\omega)^2 + \frac{(d\omega)^3}{3\pi^2 c^3} \quad -(2)$$

Rayleigh assumed that there are two states of polarization in an oscillator. Presumably this means right and left circularly polarized. In radiation of this type however there are equal and opposite $\underline{B}^{(3)}$ fields. So $\underline{B}^{(3)}$ does not contribute to the Rayleigh Jeans density of states when there are equal quantities of right and left circularly polarized radiation. In amorphous black body radiation, $\underline{B}^{(3)}$ does not contribute.

However $\underline{B}^{(3)}$ does contribute to the classical energy density of a circularly polarized

2) beam. In the standard model:

$$\frac{E_n}{V} = \epsilon_0 \left(\underline{E}^{(1)} \cdot \underline{E}^{(2)} + \underline{E}^{(2)} \cdot \underline{E}^{(1)} \right) \quad -(3)$$

$$+ \frac{1}{\mu_0} \left(\underline{B}^{(1)} \cdot \underline{B}^{(2)} + \underline{B}^{(2)} \cdot \underline{B}^{(1)} \right).$$

where:

$$\underline{E}^{(1)} = \underline{E}^{(2)*} = \frac{E^{(0)}}{\sqrt{2}} \left(\underline{i} - i\underline{j} \right) e^{i\phi} \quad -(4)$$

and

$$\underline{B}^{(1)} = \underline{B}^{(2)*} = \frac{B^{(0)}}{\sqrt{2}} \left(i\underline{i} + \underline{j} \right) e^{i\phi} \quad -(5)$$

where

$$\phi = \omega t - \kappa Z \quad -(6)$$

is the electromagnetic phase. So:

$$\frac{E_n}{V} = 2 \left(\epsilon_0 E^{(0)2} + \frac{1}{\mu_0} B^{(0)2} \right) \quad -(7)$$

where

$$E^{(0)} = cB^{(0)} \quad -(8)$$

and

$$c^2 = \frac{1}{\mu_0 \epsilon_0} \quad -(9)$$

So in the standard model:

$$\frac{E_n}{V} = 4 \epsilon_0 E^{(0)2} \quad -(10)$$

The $\underline{B}^{(3)}$ field of ECE theory adds:

$$\frac{E_n}{V} = \frac{1}{\mu_0} \underline{B}^{(3)} \cdot \underline{B}^{(3)*} = \epsilon_0 E^{(0)2} \quad -(11)$$

So in a completely circularly polarized beam the classical energy density is, in ECE theory:

$$\frac{E_n}{V} = 5 \epsilon_0 E^{(0)2} \quad -(12)$$

It is increased by a factor of 5/4 over the standard model.

In an accurately circularly polarized polychromatic beam in ECE theory, the Rayleigh Jeans density of states is increased to:

$$\frac{dN}{V} = \frac{5}{4} \left(\frac{\omega^2}{\pi^2 c^3} d\omega + \frac{\omega}{\pi^2 c^3} (d\omega)^2 + \frac{(d\omega)^3}{3\pi^2 c^3} \right) \quad -(13)$$

As in note 291(1) this expression is:

$$\frac{dN}{V} = \frac{25}{18} \frac{\omega^2}{\pi^2 c^3} d\omega \quad -(14)$$
