1) 81(5): The Faraday Effect, Rotation of Plane of Polarization by a Static Magnetic Field of Electromagnetic Radiation Interacting with One Electron.

In note 81(4) it was shown that the relation between the angular frequency of the e/m radiation, ω, and the angular frequency of the electron, Ω is:

$$\omega = \frac{1}{\gamma}\left(1 + \gamma + \frac{e\phi}{mc^2}\right)\Omega \quad -(1)$$

where:

$$\gamma = \left(1 - \frac{u^2}{c^2}\right)^{-1/2}. \quad -(2)$$

Here ϕ is the scalar potential and u is the velocity of one frame with respect to another in a Lorentz transformation. Eq(1) has assumed that the radiation is circularly polarized:

$$\underline{A} = A^{(0)}\left(\underline{i}\cos\omega t + \underline{j}\sin\omega t\right) \quad -(3)$$

in general.

The Faraday effect is the rotation of the plane of e/m radiation with a static magnetic field. This is equivalent to changing circular to elliptical polarisation. The phase of the electromagnetic field is:

2)

$$\phi = \omega t - \kappa Z$$
$$= \omega\left(t - \frac{Z}{c}\right). \quad -(4)$$

Using eq. (1):

$$\boxed{\phi = \frac{1}{\gamma}\left(1 + \gamma + \frac{e\phi}{mc^2}\right)\left(t - \frac{Z}{c}\right)\Omega} \quad -(5)$$

The effect of the extra magnetic field is to change the angular frequency Ω of the electron, so it changes ϕ. As shown in previous notes this leads to a change from circular to elliptical polarization.

<u>Details of the Effect of a Static Magnetic Field on the Motion of an Electron.</u>

As per previous notes the extra angular imparted to the electron by the static magnetic field is:

$$\Omega = \frac{e}{2m} B_{static} \quad -(6)$$

so the magnetic field changes the phase to:

$$\boxed{\phi' = \frac{1}{\gamma}\left(1 + \gamma + \frac{e\phi}{mc^2}\right)\left(t - \frac{Z}{c}\right)\left(1 + \frac{e}{2m} B_{static}\right)}$$

<u>which is the one electron Faraday effect.</u>