Notes 77(3): Angular Velocity in the Plasma Model of a Spiral Galaxy

This is analogous to the angular velocity Ω given to an electron in the inverse Faraday effect. It is:

$$\Omega = \frac{d\theta}{dt} = \frac{v}{r} = \left(\frac{v_X^2 + v_Y^2}{r_X^2 + r_Y^2} \right)^{1/2} \quad -(1)$$

where:

$$v_X = \frac{ec}{m\omega} B^{(0)} \cos \omega t \quad -(2)$$

$$v_Y = -\frac{ec}{m\omega} B^{(0)} \sin \omega t \quad -(3)$$

$$r_X = -\frac{ec^2 B^{(0)}}{\gamma \omega^2} \sin \omega t \quad -(4)$$

$$r_Y = -\frac{ec^2 B^{(0)}}{\gamma \omega^2} \cos \omega t \quad -(5)$$

$$\gamma = cm \left(1 + \left(\frac{eB^{(0)}}{m\omega} \right)^2 \right)^{1/2} . \quad -(6)$$

Here ω is the angular frequency of the beam, e and m are the charge and mass of one electron, $B^{(0)}$ is the magnetic field strength (tesla) defined by:

$$\underline{B}^{(3)} = B^{(0)} \underline{k} . \quad -(7)$$

These are results of special relativity obtained from the relativistic Hamilton Jacobi equation

2)

From eqs. (1) to (6):

$$\Omega = \frac{d\theta}{dt} = \frac{v}{r} = \left(\omega^2 + \frac{e^2 B^{(0)2}}{m^2} \right)^{1/2} \quad -(8)$$

Thus:

$$\frac{1}{r} = \frac{1}{v} \left(\omega^2 + \frac{e^2 B^{(0)2}}{m^2} \right)^{1/2} \quad -(9)$$

$$\theta = \int \frac{v}{r} \, dt . \quad -(10)$$

Eq. (8) is the angular velocity Ω of one electron due to the $\underline{B}^{(3)}$ field. The radius of the orbit is given by r in eq. (9), and the angular displacement θ by eq. (10).

The above is the effect of a circularly polarized electromagnetic field on one electron.

Spiral Galaxy

The circularly polarized e/m field in ECE theory is spinning spacetime. This concept is the link between the above equations of the inverse Faraday effect for one electron and an Alfven Lerner model of a spiral galaxy. In the arms of the latter spinning spacetime is predominant over curving spacetime (paper 76).

3) The potential is the minimal prescription of the relativistic HJ equation in the tetrad:

$$A^a_\mu = A^{(0)} q^a_\mu \quad — (11)$$

where as usual, the spacetime spin is described by Cartan's first structure equation:

$$T^a = d \wedge q^a + \omega^a{}_b \wedge q^b \quad — (12)$$

In the primordial Alfven Lerner plasma there are N electrons of charge e, giving rise to $B^{(0)}$. When this plasma of electrons is spun by spacetime, it is governed by eqs (1) to (10) for each electron of the plasma.

The spiral galaxy is the special case when v of eqs. (8) to (10) is constant:

$$v = v_0 \quad — (13)$$

as observed experimentally. So:

$$\theta = v_0 \int \frac{dt}{r} \quad — (14)$$

and:

$$\boxed{\frac{1}{r} = \frac{1}{v_0} \left(\omega^2 + \frac{e^2 B^{(0)2}}{m^2} \right)^{1/2}.} \quad — (15)$$

Now denote:

$$\tau = \int dt \quad — (16)$$

We obtain the hyperbolic spiral:

$$\theta = \frac{v_0 \tau}{r}, \quad \text{— (17)}$$

where r is given by eq. (15) in terms of v_0, ω and $B^{(0)}$. Here e and m are the charge and mass of a single electron of the primordial plasma.

The overall result is that spinning spacetime produces eq. (17) out of the parameters of eq. (15). Eq. (17) denotes one spiral. In a spiral galaxy there are several of these spirals observed to be present. The existence of several spirals may be parameterized by ω and $B^{(0)}$ of eq. (15) and graphed. This assumes that the velocity v_0 is the same for each spiral. If plasma is to form stars and matter there must be other elementary particles present such as protons. The "primordial soup" is presumably made up of quarks. So the above model is a very simple one — the simplest possible — designed to show the principles.

The angular momentum is given by:

5)

$$J_Z = m\left(r_X V_Y - r_Y V_X\right) \quad -(18)$$

$$= \frac{e^2 c^3 B^{(0)2}}{\gamma \omega^3} \quad -(19)$$

where

$$\underline{J} = J_Z \underline{k} \quad -(20)$$

The magnetic dipole moment is:

$$\underline{m} = -\frac{e}{2m} \underline{J} \quad -(21)$$

The torque is therefore:

$$\underline{Tq} = \underline{m} \times \underline{B} \quad -(22)$$

and the energy is

$$|E_n| = -m B^{(0)} \quad -(23)$$

The parameter γ is:

$$\gamma = \frac{c}{\omega}\left(m^2\omega^2 + e^2 B^{(0)2}\right)^{1/2} \quad -(24)$$

so:

$$\boxed{J_Z = \frac{e^2 c^2}{\omega^2} B^{(0)2}\left(m^2\omega^2 + e^2 B^{(0)2}\right)^{-1/2}} \quad (25)$$

$$= \frac{e^2 c^2}{\omega^2}\left(\frac{B^{(0)2}}{\left(m^2\omega^2 + e^2 B^{(0)2}\right)^{1/2}}\right)$$

6) Low Frequency Limit

Here:

$$eB^{(0)} \gg m\omega \quad -(26)$$

So:

$$J_Z \rightarrow \frac{ec^2}{\omega^2} B_Z \quad -(27)$$

or:

$$\boxed{\underline{J}^{(3)} = \frac{ec^2}{\omega^2} \underline{B}^{(3)}} \quad -(28)$$

Units

$$\underline{B}^{(3)} = J s C^{-1} m^{-2} \quad \checkmark$$

$$\underline{J}^{(3)} = J s = C m^2 s^{-2} s^2 J s C^{-1} m^{-2}$$

Conclusion

The angular momentum $\underline{J}^{(3)}$ of the spinning spiral galaxy originates in the primordial $\underline{B}^{(3)}$ field acting upon the primordial plasma. In this case we have considered only electrons.