1)

Notes 74(1): Origin of Force, Torque and Energy in Magnetic Motors.

In generally covariant unified field theory the magnetic flux density in tesla is defined by:

$$\underline{B}^a = \underline{\nabla} \times \underline{A}^a - \underline{\omega}^a{}_b \times \underline{A}^b \quad (1)$$

where $\underline{A}^a$ is the vector potential and $\underline{\omega}^a{}_b$ the spin connection vector. The magnetic flux density may be expressed as an angular momentum $\underline{L}^a$ by:

$$\underline{B}^a = \left(\frac{\mu_0 e}{4\pi M r^3} \right) \underline{L}^a \quad (2)$$

where μ_0 is the permeability of the vacuum, e is the charge, M is the mass and $\frac{4\pi r^3}{3}$ is a volume for a spherical symmetry.

In the standard model:

$$\underline{B} = \underline{\nabla} \times \underline{A} \quad (3)$$

and the spin connection is missing entirely.

Given the existence of a net magnetic dipole moment (permanent magnet):

$$\langle \underline{m} \rangle \neq \underline{0} \quad (4)$$

the spin connection generates the following linear force, torque and energy (Jackson, 3rd. ed.):

$$\underline{F}^a = -\underline{\nabla}\left(\langle \underline{m} \rangle \cdot \underline{\omega}^a{}_b \times \underline{A}^b\right) \quad -(5)$$

$$\underline{T}^a = -\langle \underline{m} \rangle \times \left(\underline{\omega}^a{}_b \times \underline{A}^b\right) \quad -(6)$$

$$En^a = \langle \underline{m} \rangle \cdot \underline{\omega}^a{}_b \times \underline{A}^b \quad -(7)$$

These quantities are missing from the standard model, which gives:

$$\underline{F} = \underline{\nabla}\left(\langle \underline{m} \rangle \cdot \underline{\nabla} \times \underline{A}\right) \quad -(8)$$

$$\underset{\sim}{T} = \langle \underline{m} \rangle \times \left(\underline{\nabla} \times \underline{A}\right) \quad -(9)$$

$$En = -\langle \underline{m} \rangle \cdot \underline{\nabla} \times \underline{A} \quad -(10)$$

The ECE theory gives the terms (8) to (10), and in addition, the terms (5) to (7).

In the standard model, the magnetic field always obeys the law:

$$\underline{\nabla} \cdot \underline{B} = 0 \quad -(11)$$

and for magnetostatics the Ampère Law:

$$\underline{\nabla} \times \underline{B} = \mu_0 \underline{J}. \quad -(12)$$

In ECE theory the corresponding laws are

$$\underline{\nabla} \cdot \underline{B}^a = \mu_0 \underline{j}^a \quad -(13)$$

$$\underline{\nabla} \times \underline{B}^a = \mu_0 \underline{J}^a \quad -(14)$$

The torque on a magnetic material in the standard model is therefore governed by:

$$\left.\begin{aligned} \underline{\nabla} \cdot \underline{B} &= 0 \\ \underline{\nabla} \times \underline{B} &= \mu_0 \underline{J} \\ \underline{T} &= \langle \underline{m} \rangle \times \underline{B} \end{aligned}\right\} \quad -(15)$$

In ECE theory the torque is governed by:

$$\left.\begin{aligned} \underline{\nabla} \cdot \underline{B}^a &= \mu_0 j^a \\ \underline{\nabla} \times \underline{B}^a &= \mu_0 \underline{J}^a \\ \underline{T}^a &= \langle \underline{m} \rangle \times \underline{B}^a \end{aligned}\right\} \quad -(16)$$

From eq. (3), the torque in ECE theory is:

$$\boxed{\underline{T}^a = \left(\frac{\mu_0 e}{m V}\right) \langle \underline{m} \rangle \times \underline{L}^a} \quad -(17)$$

where:

$$\underline{L}^a = \left(\frac{m V}{\mu_0 e}\right) \left(\underline{\nabla} \times \underline{A}^a - \underline{\omega}^a{}_b \times \underline{A}^b \right) \quad -(18)$$

$$—(19)$$

i.e. :

$$\boxed{\underline{L}^a = \left(\frac{MVA^{(0)}}{\mu_0 e}\right)\left(\underline{\nabla} \times \underline{q}^a - \underline{\omega}^a{}_b \times \underline{q}^b\right)}$$

where $\underline{q}^a$ is the vector part of the Cartan tetrad:

$$q^a_\mu = \left(q^a_0, -\underline{q}^a\right). \quad —(20)$$

The tetrad defines the Cartan torsion:

$$T^a = d \wedge q^a + \omega^a{}_b \wedge q^b \quad —(21)$$

in the notation of differential geometry.

So the origin of the torque defined in eq (16) is <u>the</u> <u>Cartan torsion</u> <u>of spacetime</u>.

In the standard model the vector potential $\underline{A}$ is used as a mathematical quantity with no relation to the Cartan torsion.

Therefore in ECE theory the torque on a magnetic material of net magnetic dipole moment $\langle m \rangle$ is:

$$\boxed{\underline{T}^a = A^{(0)} \langle \underline{m} \rangle \times \left(\underline{\nabla} \times \underline{q}^a - \underline{\omega}^a{}_b \times \underline{q}^b \right)} \quad -(22)$$

The Rotating Magnet

If:

$$\langle \underline{T}^a \rangle \neq \underline{0} \quad -(23)$$

then the magnet will rotate, because the non-zero net torque produces an angular momentum. This rotating magnet is the basis for a magnetic motor. In order to give the result (23) the average of the right hand side of eq. (22) must be non-zero. If eq. (22) is applied at the molecular level, it produces a Langevin function and anisotropy, new cross correlation functions in the lab. frame and moving frame, but the sample as a whole does not rotate. In a molecular ensemble of moving molecules:

$$\langle \underline{m} \rangle = \underline{0} \quad -(24)$$

unless the magnetization M is non-ze

6) In a permanent magnet however there is a permanent and non-zero $\langle \underline{m} \rangle$. So in order to produce a non-zero $\underline{I}^a$ from eq. (22):

$$A^{(0)} \langle \underline{\nabla} \times \underline{q}^a - \underline{\omega}^a{}_b \times \underline{q}^b \rangle \neq \underline{0}. \quad -(25)$$

The presence of $A^{(0)}$ comes from the presence of a permanent magnetization, i.e. the use of a permanent magnet. Thus:

$$\boxed{\langle \underline{\nabla} \times \underline{q}^a \rangle \neq \langle \underline{\omega}^a{}_b \times \underline{q}^b \rangle} \quad -(26)$$

<u>This is the condition needed for the magnetic motor.</u> This condition is equivalent to:

$$\langle \underline{\nabla} \times \underline{A}^a \rangle \neq \langle \underline{\omega}^a{}_b \times \underline{A}^b \rangle \quad -(27)$$

Clearly, this condition cannot exist in the standard model because the concepts of $\underline{q}^a$ and $\underline{\omega}^a{}_b$ are missing.
