Mass and charge-related properties of a rotating pre-fermion dipole

MICHAEL LAWRENCE
Maldwyn Centre for Theoretical Physics, Park Road, Ipswich, Suffolk, United Kingdom
lawrence@maldwynphysics.org
30 January 2021

Using the pre-fermion framework of previous papers, some of the mass and charge-related properties of the meon components of a loop are calculated. The specific properties are moments, the loop-equivalents of kinetic energies and potential energies, electric fields and magnetic fields of one of the three meon dipoles that exist within an electron loop. The treatment of charge in exactly the same way as mass in equations provides some interesting alternative interpretations of electromagnetic fields and forces.

Keywords: Dipole; Momentum; Energy; Loop dynamics; Relativity; Planck's constant; Electron; Magnetic moment; Pre-fermion;

PACS: 12.60.-i; 12.90.+b; 14.60.Cd; 45.20.dc; 45.50.-j; 75.10.Jm;

I. INTRODUCTION

This paper follows on from previous work on the structure of fermions based on a pre-fermion framework [1][2][3][4] and uses the same definitions. Double-adjusted SI (DASI) units are used here throughout in order to simplify equations, so there is no gravitational constant involved and the adjusted-Planck mass and charge are related by $\boldsymbol{M_*} = \boldsymbol{Q_* c}$.

II. SIGNIFICANCE and OBJECTIVES

The significance is in explaining simply, in terms of the physical pre-fermion framework of loops, what are certain of the properties of the meons and a dipole comprised of two of them. Since a loop is composed of three pairs of positive and negative meons, each on opposite sides of a loop, the properties are calculated with respect to the centre of rotation of the loop.

The objectives are to show that the properties and loop symmetry produce a stable configuration for the rotating dipoles and that each mass property has an equivalent charge property where both are treated identically. Two hypothetical mass-related and charge-related properties are derived from existing charge properties.

As shown previously [1], the usual energy and momentum equations mix how the velocity and radius of rotation components are treated. The analysis undertaken here uses the same explicit separation of the relativistic components within the dynamical energy equations. This analysis also involves non-dynamic energy and force components where the 'stationary' mass at the centre of a frame of reference is adjusted by the same factor as the velocity of the moving mass.

Treating charge in exactly the same way as mass in equations is explored to find some interesting alternative interpretations of electromagnetic fields and forces.

III. OUTLINE

The underlying foundation of the pre-fermion hypothesis is that the total energy of a meon or loop is always zero when all energies are taken into account because for each positive mass-type energy in a meon or a loop there is an equal and opposite negative mass-type energy. The same is the case for positive and negative charge energies. Furthermore, that mass-type and charge-type energies are opposite types.

In order to maintain $\boldsymbol{h}$ mass angular momentum for each meon rotating at angular frequency $\boldsymbol{w_e}$ around a loop, because the total mass of each meon depends on its fundamental mass $\boldsymbol{M_*}$ and twist energy components, as explained below, there are two possible rotational radii. The momentum of these must both be equal in size to a meon without any twist energy rotating at the normal radius for that loop. The case of one of the three dipoles that comprise the electron is considered in the framework of the centre of mass of the loop and, for certain properties, assumes that there is a small test mass $\boldsymbol{\partial m}$ or test charge $\boldsymbol{\partial q}$ located at that centre. In order to keep the sense of the relevant fields between the two meons that comprise the dipole, the sign of the test mass or charge at the centre of rotation is chosen appropriately. So the test charge related to a positive meon, of positive charge, would be negative and vice versa.

The analysis of hypothetical fields and forces which may exist is based on forming equations which replicate the correct dimensionality for those properties. Force equations require Y^8, for example, and electric fields Y^9.

No account is made for vector action of any properties in the calculations.

IV. MASS ENERGY AND MOMENTUM

The bare meon rest mass is the adjusted-Planck mass $\boldsymbol{M_*}$ and its rest mass energy is $\boldsymbol{M_* c^2}$. The mass kinetic energy of the meon in motion at $\boldsymbol{v_e}$ in an circular electron loop of angular frequency $\boldsymbol{w_e}$, where the relativistic factor

$$\gamma_e = 1/\sqrt{(1 - \boldsymbol{v_e}^2/\boldsymbol{c}^2)}$$

will be

$$E_{KE(v)} = (\gamma_e - 1)\boldsymbol{M_* c^2} = \boldsymbol{f M_* v_e}^2 = \boldsymbol{f h w_e}$$

Because the meon velocity in a stationary loop is usually low, then $\boldsymbol{v_e} \ll \boldsymbol{c}$ and $\boldsymbol{f} \cong ½$ and this is what is usually used for the general orbital kinetic energy of a relatively slow particle in motion. The factor $\boldsymbol{f}$ represents the sum of the effect of all the terms from the expansion of the relativistic factor at low velocities.

There is an important issue regarding the ½ or $\boldsymbol{f}$ factor in the treatment of energies in loops versus in 'normal' stable orbits with central mass or charge bodies.

Because the loops are dynamically bound states without any central potential source, the motion of the meons is driven by dynamic energy or force factors. This means that the meons really do rotate at ½$\boldsymbol{w}$ and not at $\boldsymbol{w}$, although each meon has $\pm\boldsymbol{h}$ of momentum and $\boldsymbol{v} = \boldsymbol{rw}$.

The adjustment required for non-dynamic energy and force components is that the 'stationary' mass or charge at the centre of a frame of reference should be adjusted by the same factor as the velocity of the moving mass, so that in the case of a base meon its mass $\boldsymbol{M_*}$ becomes $\boldsymbol{M_*\sqrt{f}}$.

In a normal orbit, the orbiting body would be observed to have $\boldsymbol{w}$ angular frequency, so that a body with ½$\boldsymbol{mv^2}$ would have ½$\boldsymbol{h}$ angular momentum and will be equated to the central potential energy for a stable orbit. The equations would be

$$\boldsymbol{PE} = \boldsymbol{mm/r} = ½\boldsymbol{mv^2} = ½(\boldsymbol{mvr})\boldsymbol{w} = ½\boldsymbol{hw} = \boldsymbol{KE}$$

As will be shown below in more detail for actual meon masses and charges in a loop, those equations are different. To differentiate between the different potential and kinetic energies, their equivalents in dynamically bound systems will be termed 'distanced' energy (DE) and 'motional' energy (ME) respectively. The equations for a dynamically bound orbit will be

$$\boldsymbol{DE} = \boldsymbol{m}(\boldsymbol{m}\sqrt{\boldsymbol{f}})/(\boldsymbol{r}/\sqrt{\boldsymbol{f}}) = \boldsymbol{fmm/r} = \boldsymbol{fmv^2} = \boldsymbol{ME}$$

even though the two are not necessarily equal or form stable orbits in such a dynamic system.

Now the simplified relationship between the equivalent energies in dynamically stable orbits is

$$\boldsymbol{mm/r} = \boldsymbol{mv^2} = \boldsymbol{hw}$$

which has lost the ½ usually ascribed to kinetic energy since it now cancels on both sides of that form of the equation.

This also extends to the treatment of forces in the systems with both sides divided by $\boldsymbol{r}/\sqrt{\boldsymbol{f}}$ in bound, or $\boldsymbol{r}$ in unbound, orbits so that the force equation is the same when simplified as a normal potentially unbound orbit as

$$F_{PE} = \boldsymbol{mm/r^2} = \boldsymbol{mv^2/r} = F_{KE}$$

$$F_{DE} = \sqrt{\boldsymbol{f}}^3\boldsymbol{mm/r^2} = \sqrt{\boldsymbol{f}}^3\boldsymbol{mv^2/r} = F_{ME}$$

This confusion over the ½ factor extends to the magnetic moment, the equivalent, adjusted by $\boldsymbol{c}$, of the mass angular momentum. The orbital magnetic moment of a normal system of radius $\boldsymbol{r_o}$, angular frequency $\boldsymbol{w_o} = \boldsymbol{2\pi/t_o}$ and charge $\boldsymbol{Q_o}$ will be

$$\boldsymbol{\mu_{orbit}} = \boldsymbol{IA} = \boldsymbol{Q_o}(\boldsymbol{\pi r_o}^2)/\boldsymbol{t_o}$$

$$= \boldsymbol{Q_o}(\boldsymbol{\pi r_o}^2)\boldsymbol{w_o/2\pi}$$

$$= \boldsymbol{Q_o v_o r_o/2}$$

$$= \boldsymbol{h/2c}$$

with energy

$$\boldsymbol{E_{orbit}} = \boldsymbol{w_o}(½\boldsymbol{h})$$

For the dynamically bound meon loop of radius $\boldsymbol{r_b}/\sqrt{\boldsymbol{f}}$, angular frequency $\boldsymbol{fw_b} = \boldsymbol{f2\pi}/(\boldsymbol{t_b/f})$ and charge $\boldsymbol{Q_b}$ will be

$$\boldsymbol{\mu_{loop}} = \boldsymbol{IA} = \boldsymbol{Q_b}(\boldsymbol{\pi r_b}^2/\boldsymbol{f})/(\boldsymbol{t_b/f})$$

$$= \boldsymbol{Q_b}(\boldsymbol{\pi r_b}^2/\boldsymbol{f})(\boldsymbol{w_b/2\pi})$$

$$= \boldsymbol{Q_b v_b r_b}/(\boldsymbol{2f})$$

$$\cong \boldsymbol{h/c}$$

with energy

$$\boldsymbol{E_{loop}} \cong \boldsymbol{h}(\boldsymbol{fw_b})$$

$$\cong \boldsymbol{h}(½\boldsymbol{w_b})$$

Although the energies of the two systems are of identical overall structure at normal loop size where $\boldsymbol{f} = ½$, the way the components are weighted is different. Whereas in the orbital system the angular frequency is $\boldsymbol{w_o}$ and the moment ½$\boldsymbol{h}$, in the loop system the split is reversed with the angular frequency ½$\boldsymbol{w_b}$ and the moment $\boldsymbol{h}$ **.** So the magnetic moment of a dynamically bound loop system is (at least) twice that of an orbital system when the components are all of the same size.

A similar issue regarding $\boldsymbol{2\pi}$ also appears to confuse which is, again, due to the difference between a normal electron atomic orbital system, orbiting at $\boldsymbol{v_a}$and $\boldsymbol{r_a}$, where $\boldsymbol{nh/2\pi = m_e v_a r_a}$ whereas the meons within a loop each have $\boldsymbol{\pm h = M_* v_e r_e}$, looking only at bare meon masses.

When considering the dynamics of actual meons within loops, rather than bare meons, each meon in an electron loop does not have just a bare mass, but has in addition a positive twist energy $\boldsymbol{s_e c^2/6}$ which is the same size as one-sixth the electron negative charge negative energy -$\boldsymbol{q_e c^3/6}$. If the meon is spiralling about an axis along its direction of travel in one direction it generates negative charge of that size and the spinning energy is positive. If the spiralling is in the other direction the charge generated will be positive that size and the spinning energy will be negative. To differentiate from the spin of the loop as a whole, this spinning is called twisting and the factor $\boldsymbol{j}$, taking positive or negative sign as appropriate, is defined for simplicity as $\boldsymbol{q_e/6 \ = \pm jQ_*}$ and $\boldsymbol{s_e/6 \ = \pm jM_*}$ with $\boldsymbol{M_* = Q_* \mathrm{c}}$ and $\boldsymbol{M_* = \sqrt{hc}}$.

The two radii that the meons can rotate at will be $\boldsymbol{r_o = (1 + k_o) r_e}$ for the outer one and $\boldsymbol{r_i = (1 - k_i) r_e}$ for the inner one, each adjusted by $\boldsymbol{\sqrt{f}}$. There is no need here to calculate the values for $\boldsymbol{k_i}$ or $\boldsymbol{k_o}$**.** Through the relationship $\boldsymbol{v_e = r_e w_e}$, or more explicitly here $(\boldsymbol{\sqrt{f} v_e}) = (\boldsymbol{r_e/\sqrt{f}})(\boldsymbol{f w_e})$, the respective velocities will be $\boldsymbol{v_o = (1 + k_o) v_e}$ and $\boldsymbol{v_i = (1 - k_i) v_e}$, again with each adjusted by $\boldsymbol{\sqrt{f}}$ **.**

The mass angular momentum equations for the meons in an electron loop will be

$$h_{M+} = (\boldsymbol{\sqrt{f} v_e})(\boldsymbol{+M_* + jM_*})(\boldsymbol{r_e/\sqrt{f}})\ (\boldsymbol{1 - k_i})^{\boldsymbol{2}}$$

$$h_{M-} = -(\boldsymbol{\sqrt{f} v_e})(\boldsymbol{-M_* + jM_*})(\boldsymbol{r_e/\sqrt{f}})\ (\boldsymbol{1 + k_o})^{\boldsymbol{2}}$$

$$= \boldsymbol{M_* v_e r_e}$$

where the larger meon rotates closer in with a lower velocity to maintain the same angular frequency $\boldsymbol{f w_e}$. It is part of the foundation of this system that the angular momentum of the positive meon is equal and opposite to that of the negative meon which results in the total mass angular momentum of the loop summing to zero across three such pairs, even though each meon is rotating in the same sense in the plane of the loop.

The resultant relationships are that

$$(\boldsymbol{+M_* + jM_*}) = \boldsymbol{M_*(1 - k_i)^{-2}}$$

$$(\boldsymbol{1 + j}) = (\boldsymbol{1 - k_i})^{\boldsymbol{-2}}$$

and

$$-(\boldsymbol{-M_* + jM_*}) = \boldsymbol{M_*(1 + k_o)^{-2}}$$

$$(\boldsymbol{1 - j}) = (\boldsymbol{1 + k_o})^{\boldsymbol{-2}}$$

The starting equation for mass motional energy using velocity of rotation also defines the same energy through angular frequency as

$$E_{ME(v)} = \boldsymbol{f M_* v_e^2} = \boldsymbol{f h w_e} = E_{ME(w)}$$

It is the case that since the rotational radii are different from the base radius $\boldsymbol{r_e}$, then different values of $\boldsymbol{f}$ should be used for those radii. However, the difference is extremely small and at the size of the electron loop the factor $\boldsymbol{f}$ is equal to ½ to within 10^{-18}, so the same value of $\boldsymbol{f}$ can be used for each radius considered here.

The result for the two meons that compose the dipole pair is that their angular momenta are

$$\boldsymbol{h_{M+}} = (\boldsymbol{\sqrt{f} v_e})(\boldsymbol{+M_* + jM_*})(\boldsymbol{r_e/\sqrt{f}})\ (\boldsymbol{1 - k_i})^{\boldsymbol{2}} = \boldsymbol{h}$$

$$\boldsymbol{h_{M-}} = (\boldsymbol{\sqrt{f} v_e})(\boldsymbol{-M_* + jM_*})(\boldsymbol{r_e/\sqrt{f}})\ (\boldsymbol{1 + k_o})^{\boldsymbol{2}} = \boldsymbol{-h}$$

Using the same momentum factors produce the motional energies

$$E_{ME(M+)} = (\boldsymbol{f v_e^2})(\boldsymbol{+M_* + jM_*})\ (\boldsymbol{1 - k_i})^{\boldsymbol{2}} = \boldsymbol{f M_* v_e^2}$$

$$E_{ME(M-)} = (\boldsymbol{f v_e^2})(\boldsymbol{-M_* + jM_*})(\boldsymbol{1 + k_o})^{\boldsymbol{2}} = \boldsymbol{-f M_* v_e^2}$$

V. CHARGE ENERGY AND MOMENTUM

The same equations can now be used to calculate the charge energy and momentum. But now the values for charge energy and charge momentum of each sign meon are not equal. The mass equivalents are equal because that is what is required to maintain the loop in a stable dynamic configuration. The charge properties are what results from the mass stability.

The foundation of this system is based on the positive meon having positive mass and positive charge, which are opposite types of energy, so that each meon has zero energy in total. This is also why the twist $\boldsymbol{s_e c^2/6}$ and charge $\boldsymbol{q_e c^3/6}$ energies are equal in size and opposite in type. So whilst mass and charge are opposite energy types, in a different way positive mass energy and negative mass energy are opposite types, with each meon attracting their own sign mass and chasing opposite sign.

For the two meon charges, the motional energies will be

$$E_{ME(Q+)} = (\boldsymbol{f v_e}^2)(+\boldsymbol{Q_*} - \boldsymbol{jQ_*})\ (\mathbf{1} - \boldsymbol{k_i})^2 \boldsymbol{c}$$

$$E_{ME(Q-)} = (\boldsymbol{f v_e}^2)(-\boldsymbol{Q_*} - \boldsymbol{jQ_*})\ (\mathbf{1} + \boldsymbol{k_o})^2 \boldsymbol{c}$$

So that in total

$$E_{ME(Qpair)} = -(\mathbf{4}\boldsymbol{jQ_*})\ \boldsymbol{f v_e}^2\ \boldsymbol{c}/(\mathbf{1} - \boldsymbol{j}^2)$$

And for the three pairs that comprise an electron loop

$$E_{ME(Qloop)} = -\boldsymbol{q_e c}\ (2\boldsymbol{f})\boldsymbol{v_e}^2\ /(\mathbf{1} - \boldsymbol{j}^2)$$

The charge motional energy of a loop is slightly more than twice what would be expected for its kinetic energy.

To calculate the charge angular momentum involves recognising that it is simply the product of magnetic moment and $\boldsymbol{c}$, such that, calling the charge angular momentum $\boldsymbol{H}$ to mirror $\boldsymbol{h}$ for mass angular momentum produces

$$H_+ = (\sqrt{\boldsymbol{f}}\boldsymbol{v_e})(+\boldsymbol{Q_*} - \boldsymbol{jQ_*})(\boldsymbol{r_e}/\sqrt{\boldsymbol{f}})\ (\mathbf{1} - \boldsymbol{k_i})^2 \boldsymbol{c}$$

$$H_- = (\sqrt{\boldsymbol{f}}\boldsymbol{v_e})(-\boldsymbol{Q_*} - \boldsymbol{jQ_*})(\boldsymbol{r_e}/\sqrt{\boldsymbol{f}})\ (\mathbf{1} + \boldsymbol{k_o})^2 \boldsymbol{c}$$

to give the total charge momentum of a pair as

$$H_{(Qpair)} = -(\mathbf{4}\boldsymbol{jQ_*})\ \boldsymbol{v_e}\ \boldsymbol{r_e c}/(\mathbf{1} - \boldsymbol{j}^2)$$

and for the electron loop

$$H_{(Qloop)} = -\mathbf{2}\boldsymbol{q_e c}\ \boldsymbol{h}\ /[\boldsymbol{M_*}(\mathbf{1} - \boldsymbol{j}^2)]$$

This produces an intrinsic magnetic moment for the electron loop of

$$\mu_{e(loop)} = -\mathbf{2}\boldsymbol{q_e}\ \boldsymbol{h}\ /[\boldsymbol{M_*}(\mathbf{1} - \boldsymbol{j}^2)]$$

This is too small by a large factor mainly because the denominator is the meon mass rather than the electron mass. If instead the equality $\boldsymbol{f M_* v_e}^2 = \boldsymbol{m_e c}^2$ was used to instead replace $\boldsymbol{M_*}$ by $\boldsymbol{m_e/f}$, the result would be a closer

$$\mu_{e(adjusted)} = -(\mathbf{2}\boldsymbol{f})\boldsymbol{q_e}\ \boldsymbol{h}\ /[\boldsymbol{m_e}(\mathbf{1} - \boldsymbol{j}^2)]$$

although still not accurate enough to explain the anomalous magnetic moment of the electron.

VI. DISTANCED TYPE ENERGIES

Here the two body system is based on the frame in which one body is stationary, or in the case of two meons in a rotating dipole, the test mass will be considered the stationary body.

For a meon dipole pair the mass distanced energies between each meon and a test mass $\boldsymbol{\partial m}$ at rest, appropriately positive or negative to replicate the gravitational field between the two meons and adjusted by $\sqrt{\boldsymbol{f}}$, will be

$$E_{DE(M+)} = (+\boldsymbol{M_*} + \boldsymbol{jM_*})(-\boldsymbol{\partial m}\sqrt{\boldsymbol{f}})\ /[(\mathbf{1} - \boldsymbol{k_i})\boldsymbol{r_e}/\sqrt{\boldsymbol{f}}]$$

$$E_{DE(M-)} = (-\boldsymbol{M_*} + \boldsymbol{jM_*})(+\boldsymbol{\partial m}\sqrt{\boldsymbol{f}})\ /[(\mathbf{1} + \boldsymbol{k_o})\boldsymbol{r_e}/\sqrt{\boldsymbol{f}}]$$

which can be simplified to

$$E_{DE(M+)} = -\boldsymbol{f}\sqrt{\mathbf{1} + \boldsymbol{j}}^{\,\mathbf{3}}\boldsymbol{M_*\partial m}\ /\boldsymbol{r_e}$$

$$E_{DE(M-)} = -\boldsymbol{f}\sqrt{\mathbf{1} - \boldsymbol{j}}^{\,\mathbf{3}}\boldsymbol{M_*\partial m}\ /\boldsymbol{r_e}$$

This result may appear to be half the usual expectation for potential energy, but, as explained earlier, can be equated to the motional energy if it were part of a stable orbit.

The same treatment for charge starts simply but produces a more complex result

$$E_{DE(Q+)} = (+\boldsymbol{Q_*} - \boldsymbol{jQ_*})(-\boldsymbol{\partial q}\sqrt{\boldsymbol{f}})\boldsymbol{c}^2\ /[(\mathbf{1} - \boldsymbol{k_i})\boldsymbol{r_e}/\sqrt{\boldsymbol{f}}]$$

$$E_{DE(Q-)} = (-\boldsymbol{Q_*} - \boldsymbol{jQ_*})(+\boldsymbol{\partial q}\sqrt{\boldsymbol{f}})\ \boldsymbol{c}^2/[(\mathbf{1} + \boldsymbol{k_o})\boldsymbol{r_e}/\sqrt{\boldsymbol{f}}]$$

so that

$$E_{DE(Q+)} = -\boldsymbol{f}\sqrt{\mathbf{1} - \boldsymbol{j} - \boldsymbol{j}^2 + \boldsymbol{j}^3}\boldsymbol{Q_*\partial q c}^2\ /\boldsymbol{r_e}$$

$$E_{DE(Q-)} = -\boldsymbol{f}\sqrt{\mathbf{1} + \boldsymbol{j} - \boldsymbol{j}^2 - \boldsymbol{j}^3}\boldsymbol{Q_*\partial q c}^2\ /\boldsymbol{r_e}$$

It is interesting that neither mass nor charge distanced energies are equal for the two meons.

VII. DISTANCED TYPE FORCES

For the same system as above, the distanced type mass forces between the two meons at their centre of rotation, split into two parts, will be

$$F_{D(M+)} = (+\boldsymbol{M_*} + \boldsymbol{jM_*})(-\boldsymbol{\partial m}\sqrt{\boldsymbol{f}})\ /[(\mathbf{1} - \boldsymbol{k_i})\boldsymbol{r_e}/\sqrt{\boldsymbol{f}}]^{\mathbf{2}}$$

$$F_{D(M-)} = (-\boldsymbol{M_*} + \boldsymbol{jM_*})(+\boldsymbol{\partial m}\sqrt{\boldsymbol{f}})\ /[(\mathbf{1} + \boldsymbol{k_o})\boldsymbol{r_e}/\sqrt{\boldsymbol{f}}]^{\mathbf{2}}$$

which can be simplified to

$$F_{D(M+)} = -\sqrt{\boldsymbol{f}}^{\,\mathbf{3}}(\mathbf{1} + \boldsymbol{j})^{\mathbf{2}}\boldsymbol{M_*\partial m}\ /\boldsymbol{r_e}^{\mathbf{2}}$$

$$F_{D(M-)} = -\sqrt{\boldsymbol{f}}^{3}(\mathbf{1}-\boldsymbol{j})^2\boldsymbol{M}_*\boldsymbol{\partial m}\,/\boldsymbol{r_e}^2$$

In the same way, the distanced charge force between two meons, split into parts, at their centre of rotation will be

$$F_{D(Q+)} = (+\boldsymbol{Q}_* - \boldsymbol{jQ}_*)(-\boldsymbol{\partial q}\sqrt{\boldsymbol{f}})\boldsymbol{c}^2\,/[(\mathbf{1}-\boldsymbol{k_i})\boldsymbol{r_e}/\sqrt{\boldsymbol{f}}]^2$$

$$F_{D(Q-)} = (-\boldsymbol{Q}_* - \boldsymbol{jQ}_*)(+\boldsymbol{\partial q}\sqrt{\boldsymbol{f}})\,\boldsymbol{c}^2/[(\mathbf{1}+\boldsymbol{k_o})\boldsymbol{r_e}/\sqrt{\boldsymbol{f}}]^2$$

which can be simplified to

$$F_{D(Q+)} = -\sqrt{\boldsymbol{f}}^{3}(\mathbf{1}-\boldsymbol{j}^2)\boldsymbol{Q}_*\boldsymbol{\partial q}\boldsymbol{c}^2\,/\boldsymbol{r_e}^2$$

$$F_{D(Q-)} = -\sqrt{\boldsymbol{f}}^{3}(\mathbf{1}-\boldsymbol{j}^2)\boldsymbol{Q}_*\boldsymbol{\partial q}\boldsymbol{c}^2\,/\boldsymbol{r_e}^2$$

So the distanced charge force from each of the two meons is the same at the centre of rotation.

VIII. DYNAMIC FORCES

Considering the outward forces on the rotating meons, rather than at the centre of rotation, due to the rotational velocity of the meon masses produces

$$F_{V(M+)} = (+\boldsymbol{M}_* + \boldsymbol{jM}_*)\boldsymbol{f}[(\mathbf{1}-\boldsymbol{k_i})\boldsymbol{v_e}]^2\,/[(\mathbf{1}-\boldsymbol{k_i})\boldsymbol{r_e}/\sqrt{\boldsymbol{f}}]$$

$$F_{V(M-)} = (-\boldsymbol{M}_* + \boldsymbol{jM}_*)\boldsymbol{f}[(\mathbf{1}+\boldsymbol{k_o})\boldsymbol{v_e}]^2\,/[(\mathbf{1}+\boldsymbol{k_o})\boldsymbol{r_e}/\sqrt{\boldsymbol{f}}]$$

which simplifies to

$$F_{V(M+)} = \sqrt{1+\boldsymbol{j}}\sqrt{\boldsymbol{f}}^{3}\boldsymbol{M}_*\boldsymbol{v_e}^2\,/\boldsymbol{r_e}$$

$$F_{V(M-)} = \sqrt{1-\boldsymbol{j}}\sqrt{\boldsymbol{f}}^{3}\boldsymbol{M}_*\boldsymbol{v_e}^2\,/\boldsymbol{r_e}$$

For the meon charges the dynamic forces are

$$F_{V(Q+)} = (+\boldsymbol{Q}_* - \boldsymbol{jQ}_*)\boldsymbol{c}\sqrt{\boldsymbol{f}}^{3}\,[(\mathbf{1}-\boldsymbol{k_i})\boldsymbol{v_e}]^2/[(\mathbf{1}-\boldsymbol{k_i})\boldsymbol{r_e}]$$

$$F_{V(Q-)} = (-\boldsymbol{Q}_* - \boldsymbol{jQ}_*)\boldsymbol{c}\sqrt{\boldsymbol{f}}^{3}\,[(\mathbf{1}+\boldsymbol{k_o})\boldsymbol{v_e}]^2/[(\mathbf{1}+\boldsymbol{k_o})\boldsymbol{r_e}]$$

which simplifies to

$$F_{V(Q+)} = (\mathbf{1}-\boldsymbol{j})\sqrt{\boldsymbol{f}}^{3}\boldsymbol{Q}_*\boldsymbol{c}\boldsymbol{v_e}^2\,/(\sqrt{1+\boldsymbol{j}}\boldsymbol{r_e})$$

$$F_{V(Q-)} = -(\mathbf{1}+\boldsymbol{j})\sqrt{\boldsymbol{f}}^{3}\boldsymbol{Q}_*\boldsymbol{c}\boldsymbol{v_e}^2\,/(\sqrt{1-\boldsymbol{j}}\boldsymbol{r_e})$$

IX. CHARGE FIELDS

So far the analysis has looked at the mass side of the fields and forces in action between the meons in the dipole and then replicated the same equations for the charge side. This could be continued further except that there are no directly specific recognised equivalents to some of the charge fields. So this section will reverse the process and look at charge fields and then replicate what the equivalent hypothetical mass field would be.

The first charge field is the electric field and it is simply the charge force field without the test charge, in its negative and positive form, at the centre of rotation. The two electric fields are thus

$$\boldsymbol{\varepsilon}_{D(Q+)} = +\boldsymbol{f}(\mathbf{1}-\boldsymbol{j}^2)\boldsymbol{Q}_*\boldsymbol{c}^2\,/\boldsymbol{r_e}^2$$

$$\boldsymbol{\varepsilon}_{D(Q-)} = -\boldsymbol{f}(\mathbf{1}-\boldsymbol{j}^2)\boldsymbol{Q}_*\boldsymbol{c}^2\,/\boldsymbol{r_e}^2$$

This means that the fields act in the same sense along the dipole, running from positive charge meon towards small negative test charge at the centre, then from equally small positive test charge at the centre towards the negative meon, but sum to zero at the centre of rotation.

The equivalent for the hypothetical mass-electric field is the gravitational force as before, but without the test mass

$$\boldsymbol{\varepsilon}_{D(M+)} = +\boldsymbol{f}(\mathbf{1}+\boldsymbol{j})^2\boldsymbol{M}_*\boldsymbol{c}\,/\boldsymbol{r_e}^2$$

$$\boldsymbol{\varepsilon}_{D(M-)} = -\boldsymbol{f}(\mathbf{1}-\boldsymbol{j})^2\boldsymbol{M}_*\,\boldsymbol{c}/\boldsymbol{r_e}^2$$

The total mass-electric field for each pair will be

$$\boldsymbol{\varepsilon}_{D(pair)} = 4\boldsymbol{fjM}_*\,\boldsymbol{c}/\boldsymbol{r_e}^2$$

and for the electron loop will be

$$\boldsymbol{\varepsilon}_{D(loop)} = (2\boldsymbol{f})\sqrt{\boldsymbol{\alpha}/\mathbf{2}\boldsymbol{\pi}}\boldsymbol{M}_*\boldsymbol{c}\,/\boldsymbol{r_e}^2$$

There is no evidence to suggest that such a mass-electric field exists although the dimensionality is the same as shear viscosity.

The second charge field is the magnetic field which for the two meons will be the electric field divided by the velocity of each

$$\boldsymbol{B}_{D(Q+)} = +\sqrt{\boldsymbol{f}}(\mathbf{1}-\boldsymbol{j}^2)\boldsymbol{Q}_*\boldsymbol{c}^2\,/((\mathbf{1}-\boldsymbol{k_i})\boldsymbol{v_e}\boldsymbol{r_e}^2)$$

$$\boldsymbol{B}_{D(Q-)} = -\sqrt{\boldsymbol{f}}(\mathbf{1}-\boldsymbol{j}^2)\boldsymbol{Q}_*\boldsymbol{c}^2\,/((\mathbf{1}+\boldsymbol{k_o})\boldsymbol{v_e}\boldsymbol{r_e}^2)$$

which can be simplified to some extent as

$$\boldsymbol{B}_{D(Q+)} = +\sqrt{\boldsymbol{f}}(\mathbf{1}-\boldsymbol{j}^2)\boldsymbol{Q}_*\boldsymbol{c}^2\,/(\sqrt{(\mathbf{1}+\boldsymbol{j})}\boldsymbol{v_e}\boldsymbol{r_e}^2)$$

$$\boldsymbol{B}_{D(Q-)} = -\sqrt{\boldsymbol{f}}(\mathbf{1}-\boldsymbol{j}^2)\boldsymbol{Q}_*\boldsymbol{c}^2\,/(\sqrt{(\mathbf{1}-\boldsymbol{j})}\boldsymbol{v_e}\boldsymbol{r_e}^2)$$

At the centre of rotation the total $\boldsymbol{B}$ field would be

$$\boldsymbol{B}_{D(Q)} = \sqrt{\boldsymbol{f}}\boldsymbol{Q}_*\boldsymbol{c}^2\,\sqrt{(\mathbf{1}-\boldsymbol{j}^2)}(\sqrt{\mathbf{1}-\boldsymbol{j}} - \sqrt{\mathbf{1}+\boldsymbol{j}})/\boldsymbol{v_e}\boldsymbol{r_e}^2$$

The equivalent for the hypothetical mass-magnetic field would be

$$\boldsymbol{B}_{D(M+)} = +\sqrt{\boldsymbol{f}}(\mathbf{1}+\boldsymbol{j})^2\boldsymbol{M}_*\,\boldsymbol{c}/((\mathbf{1}-\boldsymbol{k}_i)\boldsymbol{v}_e\boldsymbol{r}_e{}^2)$$

$$\boldsymbol{B}_{D(M-)} = -\sqrt{\boldsymbol{f}}(\mathbf{1}-\boldsymbol{j})^2\boldsymbol{M}_*\,\boldsymbol{c}/((\mathbf{1}+\boldsymbol{k}_o)\boldsymbol{v}_e\boldsymbol{r}_e{}^2)$$

simplified to

$$\boldsymbol{B}_{D(M+)} = +\sqrt{\boldsymbol{f}}(\mathbf{1}+\boldsymbol{j})^{5/2}\boldsymbol{M}_*\,\boldsymbol{c}/(\boldsymbol{v}_e\boldsymbol{r}_e{}^2)$$

$$\boldsymbol{B}_{D(M-)} = -\sqrt{\boldsymbol{f}}(\mathbf{1}-\boldsymbol{j})^{5/2}\boldsymbol{M}_*\boldsymbol{c}\,/(\boldsymbol{v}_e\boldsymbol{r}_e{}^2)$$

which can be further simplified to

$$\boldsymbol{B}_{D(M+)} = +\sqrt{\boldsymbol{f}}(\mathbf{1}+\boldsymbol{j})^{5/2}\boldsymbol{M}_*{}^2\boldsymbol{c}\,/\boldsymbol{h}\boldsymbol{r}_e$$

$$\boldsymbol{B}_{D(M+)} = -\sqrt{\boldsymbol{f}}(\mathbf{1}-\boldsymbol{j})^{5/2}\boldsymbol{M}_*{}^2\boldsymbol{c}\,/\boldsymbol{h}\boldsymbol{r}_e$$

So far the equations in this section have been based on the distanced -like interactions, from meon to test mass, or nothing, at the centre of rotation. It is interesting to understand whether there is any observable effect from the hypothetical velocity equivalents.

X. HYPOTHETICAL DYNAMIC CHARGE FIELDS

These would be, for the dynamic electric fields, the equivalent of reinstating the appropriate test charge, with its associated $\boldsymbol{c}$ factor, into the charge force equations thus

$$\boldsymbol{\varepsilon}_{V(Q+)} = (\mathbf{1}-\boldsymbol{j})\sqrt{\boldsymbol{f}}^{\mathbf{3}}\boldsymbol{Q}_*(-\boldsymbol{\partial q}\sqrt{\boldsymbol{f}})\boldsymbol{c}^2\boldsymbol{v}_e{}^2\,/(\sqrt{1+\boldsymbol{j}}\boldsymbol{r}_e)$$

$$\boldsymbol{\varepsilon}_{V(Q-)} = -(\mathbf{1}+\boldsymbol{j})\sqrt{\boldsymbol{f}}^{\mathbf{3}}\boldsymbol{Q}_*(\boldsymbol{\partial q}\sqrt{\boldsymbol{f}})\boldsymbol{c}^2\boldsymbol{v}_e{}^2\,/(\sqrt{1-\boldsymbol{j}}\boldsymbol{r}_e)$$

For the hypothetical dynamic charge magnetic fields, the equivalent equations would again just be the electric fields divided by the velocity as

$$\boldsymbol{B}_{V(Q+)} = -(\mathbf{1}-\boldsymbol{j})\sqrt{\boldsymbol{f}}^{\mathbf{3}}\boldsymbol{Q}_*\boldsymbol{\partial q}\boldsymbol{c}^2\boldsymbol{v}_e{}^2/[\boldsymbol{v}_e(\mathbf{1}-\boldsymbol{k}_i)(\sqrt{1+\boldsymbol{j}}\boldsymbol{r}_e)]$$

$$\boldsymbol{B}_{V(Q-)} = -(\mathbf{1}+\boldsymbol{j})\sqrt{\boldsymbol{f}}^{\mathbf{3}}\boldsymbol{Q}_*\boldsymbol{\partial q}\boldsymbol{c}^2\boldsymbol{v}_e{}^2/[\boldsymbol{v}_e\,(\mathbf{1}+\boldsymbol{k}_o)(\sqrt{1-\boldsymbol{j}}\boldsymbol{r}_e)]$$

which becomes

$$\boldsymbol{B}_{V(Q+)} = -(\mathbf{1}-\boldsymbol{j})\sqrt{\boldsymbol{f}}^{\mathbf{3}}\boldsymbol{Q}_*\boldsymbol{\partial q}\boldsymbol{c}^2\boldsymbol{w}_e$$

$$\boldsymbol{B}_{V(Q-)} = -(\mathbf{1}+\boldsymbol{j})\sqrt{\boldsymbol{f}}^{\mathbf{3}}\boldsymbol{Q}_*\boldsymbol{\partial q}\boldsymbol{c}^2\boldsymbol{w}_e$$

A comparison of the charge magnetic field calculated using the distanced route versus the velocity route suggests that if there is such a velocity-generated field it is additive rather than subtractive. This will be the subject of further study.

The total of such a velocity-generated magnetic field for a dipole pair of meons, requiring dimensionality Y^7 would be

$$\boldsymbol{B}_{V(Qpair)} = -(\mathbf{2}\sqrt{\boldsymbol{f}}^{\mathbf{3}})\boldsymbol{Q}_*\boldsymbol{\partial q}\boldsymbol{c}^2\boldsymbol{w}_e$$

and for the electron loop would be

$$\boldsymbol{B}_{V(Qloop)} = -3(\mathbf{2}\sqrt{\boldsymbol{f}}^{\mathbf{3}})\boldsymbol{Q}_*\boldsymbol{\partial q}\boldsymbol{c}^2\boldsymbol{w}_e$$

If the test charge were of size $\boldsymbol{j}$, then the field would be

$$\boldsymbol{B}_{V(Qloop-j)} = -\sqrt{\boldsymbol{f}}^{\mathbf{3}}\boldsymbol{q}_e\boldsymbol{Q}_*\boldsymbol{c}^2\boldsymbol{w}_e$$

or

$$\boldsymbol{B}_{V(Qloop-j)} = -\sqrt{\boldsymbol{\alpha}/\mathbf{2}\boldsymbol{\pi}}\boldsymbol{c}(\sqrt{\boldsymbol{f}}^{\mathbf{3}}\boldsymbol{h}\boldsymbol{w}_e)$$

XI. STABILITY OF LOOPS

It might be thought that where there are different forces or fields acting at the centre of rotation between the two meons comprising a dipole, that the loop should be unstable. However, there are three dipoles symmetrically centred on the centre of rotation so that, for the electron and other symmetric loops, there will always be a total zero field or force acting at the centre.

XII. MASS VERSUS CHARGE PROPERTIES

This section provides a simplified comparison of the equations using mass and charge identically. Instead of looking at actual meon masses and charges adjusted for $\boldsymbol{j}$ content, it uses only the shortened definitions for base meon mass $\boldsymbol{M}_*$ and charge $\boldsymbol{Q}_*$ as $\boldsymbol{M}$ and $\boldsymbol{Q}$ respectively, for brevity. No use of $\boldsymbol{q}_e$ is made since that is a loop property.

Additionally the formulae are based on a system where the orbits may be stable dynamically or potentially and do not consider the sign of mass or charge or any vector component, looking only at size.

The comparisons are delineated by power of dimension and note what the overall property outcome is, starting with the basic properties and using $\boldsymbol{Qc}$ for charge unless necessary for a definition of a higher property. Some properties appear in more than one guise and suggest interesting alternative interpretations of what the mass-related and electromagnetic fields and forces represent.

	MASS	CHARGE
Y^1	$\boldsymbol{M}$	$\boldsymbol{Qc}$ or $\boldsymbol{Qv}$
	mass	magnetic flux

Y^2	$\boldsymbol{v}$ or $\boldsymbol{c}$ / $\boldsymbol{R}$	$\boldsymbol{v}$ or $\boldsymbol{c}$ / $\boldsymbol{R}$
	velocity/resistance	velocity/resistance
Y^{-3}	$\boldsymbol{r}$	$\boldsymbol{r}$
	distance/radius	distance/radius
Y^{-5}	$\boldsymbol{t}$	$\boldsymbol{t}$
	time	time
Y^5	$\boldsymbol{w}$	$\boldsymbol{w}$
	angular frequency	angular frequency
Y^8	$\boldsymbol{F}$	$\boldsymbol{F}$
	force	force
Y^0	$\boldsymbol{Mvr = h}$	$\boldsymbol{Qcvr = h}$
	angular momentum	angular momentum
Y^3	$\boldsymbol{Mv}$	$\boldsymbol{Qcv}$
	momentum	momentum
Y^4	$\boldsymbol{M/r}$	$\boldsymbol{Qc/r}$
	moment	moment
Y^4	$\boldsymbol{M/ct}$	$\boldsymbol{Q/t = I}$
	none	current
Y^5	$\boldsymbol{fMv^2}$	$\boldsymbol{fQcv^2}$
	kinetic energy	kinetic energy
Y^5	$\boldsymbol{fMv^2}$	$\boldsymbol{fQcv^2}$
	motional energy	motional energy
Y^5	$\boldsymbol{MM/r}$	$\boldsymbol{QQc^2/r}$
	potential energy	potential energy
Y^5	$\boldsymbol{fMM/r}$	$\boldsymbol{fQQc^2/r}$
	distanced energy	distanced energy
Y^5	$\boldsymbol{fMvrw = fhw}$	$\boldsymbol{fQcvrw = fhw}$
	mass energy	spin energy
Y^6	$\boldsymbol{Mc/r}$	$\boldsymbol{Qc^2/r}$
	none	potential difference

Y^7	$\boldsymbol{(MM/r^2)/M = a}$	$\boldsymbol{(QQc^2/r^2)/Qv = B}$
	acceleration	magnetic field
Y^7	$\boldsymbol{Mc/vr^2}$	$\boldsymbol{Mc^2/vr^2 = B}$
	mass magnetic field	magnetic field
Y^7	$\boldsymbol{(M/r^2)(c/v)}$	$\boldsymbol{(Qc/r^2)(c/v) = B}$
	mass magnetic field	magnetic field
Y^7	$\boldsymbol{v^2/r}$	$\boldsymbol{v^2/r}$
	acceleration	acceleration
Y^7	$\boldsymbol{(Mc/r^2)/c}$	$\boldsymbol{\varepsilon/c}$
	acceleration	acceleration
Y^8	$\boldsymbol{MM/r^2}$	$\boldsymbol{QQc^2/r^2}$
	force (potential)	force (potential)
Y^8	$\sqrt{\boldsymbol{f}}^{\boldsymbol{3}}\boldsymbol{MM/r^2}$	$\sqrt{\boldsymbol{f}}^{\boldsymbol{3}}\boldsymbol{QQc^2/r^2}$
	force (distanced)	force (distanced)
Y^8	$\boldsymbol{Mv^2/r}$	$\boldsymbol{Qcv^2/r}$
	force (kinetic)	force (kinetic)
Y^8	$\sqrt{\boldsymbol{f}}^{\boldsymbol{3}}\boldsymbol{Mv^2/r}$	$\sqrt{\boldsymbol{f}}^{\boldsymbol{3}}\boldsymbol{Qcv^2/r}$
	force (motional)	force (motional)
Y^8	$\boldsymbol{Ma}$	$\boldsymbol{(Qc)(Bv/c)}$
	force	force
Y^8	$\boldsymbol{Ma}$	$\boldsymbol{(Qv)B}$
	force	force
Y^8	$\boldsymbol{Ma}$	$\boldsymbol{Q\varepsilon}$
	force	force
Y^8	$\boldsymbol{Ma}$	$\boldsymbol{(Qc)(\varepsilon/c)}$
	force	force
Y^9	$\boldsymbol{Mc/r^2}$	$\boldsymbol{Qc^2/r^2 = \varepsilon}$
	shear viscosity	electric field
Y^{-2}	$\boldsymbol{Mvr/c}$	$\boldsymbol{Qvr = \mu}$
	mass magnetic moment	magnetic moment

Some specific points worth noting amongst these formulae are that some outcomes are not associated with properties and some were called hypothetical in the main part of this paper. Also, that in the same way that all mass sizes are equally affected in gravitational fields, the same is true for all charge sizes in charge fields where in both cases their accelerations are independent of their sizes if $\boldsymbol{Qv}$ is the magnetic flux rather than $\boldsymbol{Qc}$.

XIII. CONCLUSION

This analysis has shown that at the pre-fermion level the normal equations governing orbital motion are not universally valid. The dynamically-bound motion of meons in loops shows that even when the forces at the centre of a rotating dipole, formed by a positive and negative meon, are not equal, the loop can still be stable overall. Treatment of charges in equations in exactly the same way as masses provides some interesting alternative interpretations of electromagnetic fields and forces.

XIV. REFERENCES

1 Lawrence, M.; Why the intrinsic spin quantum number of a fermion is h and not ½ h and how to correctly reconcile velocities in momentum and energy equations (pre-print), Researchgate (2020)

2 Lawrence, M.: A viscosity hypothesis – that the presence or absence of viscosity separates relativistic and quantum systems based on the simplest possible theory of everything, LAP Lambert Academic Publishing (2017) ISBN: 978-3-330-08736-1

3 Lawrence, M.: A hypothetical pre-fermion particle theory of everything based on 95 theses (pre-print), Researchgate, (2018)

4 Lawrence, M.: A physical explanation for why the electron spin g-factor exceeds 2 (pre-print), Researchgate, (2020)