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DISCRIMINATING AMONGST COMPOSITE MODELS OF THE LEPTONS, USING SPIN POLARIZATION PRECESSION

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By considering a series of composite models for the charged leptons, we demonstrate that with influence of perturbations generated by Markov process in high magnetic fields, we can arrive at criteria which allow us to discriminate amongst the models using spin polarization precession.

1. Introduction

In the field of elementary particle physics, despite the great achievements of the past thirty years, we are now in need of both new ideas and new experiments to probe for a more predictive and less phenomenological theory [1]. The preference for left over right in weak interaction, the origin of the generations, the origin of quark and lepton masses, and an understanding of the Higgs sector with its associated symmetry breaking and its effect on theories of quark mixing and CP violations represent some of the nagging problems that a more fundamental theory than $SU(3)_C \times SU(2)_L \times U(1)_Y$ standard model must resolve [2,3].

Amongst the proposals to go beyond the standard model, Technicolour has been suggested as a theory of the composite structure of Higgs particles [4], and

Grandunification has been proposed as a theory that unites the coupling into one coupling constant at higher energy as well as putting quarks and leptons into the same multiplet [5]. In addition to these two proposals, supersymmetry [6] has been suggested as a solution to the hierarchy problem invented to stabilize the electroweak scale and G.U.T. scale, and superstring theory [7] is an attempt to unify all forces in ten dimensions with the low energy standard model appearing after compactification of six of the dimensions. The other attempt at unification is that of compositeness which suggests that all quarks, leptons, qauge bosons and Higgs particles are really composites of fundamental preons with new forces, such as hypercolour, binding the preons together and generating an effective standard model when viewed at low energy [8,9]. Compositeness seems like a very natural assumption for a theory of quarks, leptons and gauge bosons since all previous systems (atoms, nuclei, hadrons) have revealed a composite structure and perhaps the next step is to uncover the composite structure of leptons and quarks [10]. One of the major problems with a composite theory of quarks and leptons is that the maximum size of a quark and lepton suggests a binding energy for the composite system that far exceeds the mass of the quark and lepton [11]. This suggests that the system is protected by either a chiral–flavour symmetry or supersymmetry from acquiring a mass that far exceeds the known quark or lepton mass. Numerous composite models have been proposed [12–14] with the three fermion and fermion–boson models being the most popular. The principle probes to compositeness include the study of anomalous magnetic moments, modifications of form factors and rare decays [15]. In previous notes, we have suggested a different probe to compositeness, namely if space and time attain a discrete or grainy–like nature at some scale, the composite structure of leptons and gauge bosons should show up in spin polarization precession experiments [16–19]. We have also demonstrated that composite particles will exhibit spectral shifts from a spin flip in external magnetic fields due to composite structure in a discrete time difference quantum theory [20,21]. The idea of discrete time quantum theory goes back to the historic papers of Caldirola [22,23] but also has its roots in the pregeometric ideas of Wheeler [24], Finkelstein [25] and Bombelli et al. [26]. Another way of putting a discrete time notion into quantum theory is through the idea of Markov jump processes [27]. We have shown how Markov effects on individual preons should show up in spin polarization precession experiments and in fact the details of how a spin polarization amplitude varies for short time intervals would serve as a window through which to study the composite structure of the precessing particle [19]. In Ref. 18 we discussed how Markov effects on a two preon composite gauge boson would leave definite signatures in spin polarization precession experiments and in a subsequent note [28] we discussed the signatures that a three fermion and a fermion–boson system would produce due to Markov jump process. In what follows, we study a series of models of composite lepton structure using the effect that Markov process have on spin polarization precession. We also discuss a Rishon model without the need for hypercolour [29,30], and in closing we point out that the random chaotic effects produced in a spin polarization precession in high magnetic fields offers a clean distinct probe for composite lepton structure.

2. Signature of composite models of the leptons using spin polarization precession

As mentioned in the *Introduction*, we seek to explore a variety of composite charged lepton models with the intent of demonstrating that each generates distinct signatures in spin polarization precession due to environmental Markov effects that effect individual preons in high magnetic fields. The justification for such a study is motivated by the "Procrustean Principle" [31] which states that systems in the low energy world are unavoidably "open system" due to non–local string modes interacting with localized string modes (particles). I might also remark that not all interactions are "Hamiltonian", there is always the possibility of environmental effects that canot be put in hamiltonian form [32]. To begin our discussion of composite models, we first review a model appearing in Ref. 28, two identical fermions and one different. The charge and masses are

$$q_I = q_{II} = -e_1,\ \ q_{III} = -e_2,\ \ m_I = m_{II} = m_1,\ \ m_{III} = m_2.$$

For the hamiltonian in an external magnetic field we have

$$H = \frac{e_1}{m_1} S_{z_1} B + \frac{e_1}{m_1} S_{z_2} B + \frac{e_2}{m_2} S_{z_3} B. \tag{2.1}$$

To insure that the spin up state has $E_+ = e\hbar B/2m$ (m is the mass of charged lepton) and the spin down has $E_- = -e\hbar B/2m$, we have [28] $e_1/m_1 = e_2/m_2 = e/m$ ($-e$ is charge of lepton, m is mass of lepton).

Here we do not include the internal dynamics which must generate the rest mass of the charged lepton. For the spin up state we write

$$\Psi_\uparrow = \frac{1}{\sqrt{2}}(\alpha(1)\beta(2) - \beta(1)\alpha(2))\alpha(3) e^{-\mathrm{i}E_+ t/\hbar} \tag{2.2}$$

and for spin down

$$\Psi_\downarrow = \frac{1}{\sqrt{2}}(\alpha(1)\beta(2) - \beta(1)\alpha(2))\beta(3) e^{-\mathrm{i}E_- t/\hbar}. \tag{2.3}$$

Here we have anty–symmetrized the spin function of the two identical fermions. We now consider a two step Markov process that influences each spin, calling:

$P_n(+)$ is the probability of spin up for fermions 1 and 2,
$P_n(-)$ is the probability of spin down for fermions 1 and 2,
$\overline{P}_n(+)$ is the probability of spin up for fermion 3,
$\overline{P}_n(-)$ is the probability of spin down for fermion 3 (n refers to number of steps).

For a two step Markov process [27], we have $P_0(\pm) = 1/2$

$$P_n(+) = \frac{p}{p+q} + (1-p-q)^n \left(\frac{1}{2} - \frac{p}{p+q}\right)$$

$$P_n(-) = \frac{q}{p+q} + (1-p-q)^n \left(\frac{1}{2} - \frac{q}{p+q}\right) \tag{2.4}$$

(after n steps).

Here p is probability of jump from $-$ to $+$ and q is probability of jump for $+$ to $-$. The two state transition matrix is

$$M = \begin{matrix} \\ + \\ - \end{matrix} \begin{matrix} \quad + \quad\quad - \\ \begin{pmatrix} 1-q, & q \\ p, & 1-p \end{pmatrix} \end{matrix} \tag{2.5}$$

for preons 1 and 2, and

$$M = \begin{matrix} \\ + \\ - \end{matrix} \begin{matrix} \quad + \quad\quad - \\ \begin{pmatrix} 1-\overline{q}, & \overline{q} \\ \overline{p}, & 1-\overline{p} \end{pmatrix} \end{matrix} \tag{2.6}$$

for preon 3.

Here p, q, $\overline{p}$, $\overline{q}$ depend on the external magnetic field B. To take into account Markov effects, we modify the spin function in Eqs. (2.2) and (2.3) and take the linear combination necessary to generate spin precession in the xy plane [18]

$$\Psi = \frac{1}{\sqrt{2}}\Psi_\uparrow + \frac{1}{\sqrt{2}}\Psi_\downarrow$$

$$\Psi = \sqrt{2}\left(\sqrt{P_n(+)P_n(-)\overline{P}_n(+)}\alpha\beta\alpha - \sqrt{P_n(-)P_n(+)\overline{P}_n(+)}\beta\alpha\alpha\right) e^{-\mathrm{i}E_+ t/\hbar}$$

$$+\sqrt{2}\left(\sqrt{P_n(+)P_n(-)\overline{P}_n(-)}\alpha\beta\beta - \sqrt{P_n(-)P_n(+)\overline{P}_n(-)}\beta\alpha\beta\right) e^{-\mathrm{i}E_- t/\hbar}. \tag{2.7}$$

Here the Markov probabilities $P_n(\pm)$ are the same for preons 1 and 2, $\overline{P}_n(\pm)$ refers to preon 3.

We now evaluate

$$< S_{x_1} + S_{x_2} + S_{x_3} > \tag{2.8}$$

for the wave function in Eq. (2.7). Using the matrices for

$$S_{x_1} = S_{x_2} = S_{x_3} = \frac{\hbar}{2}\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix},$$

we have

$$< S_{x_1} + S_{x_2} + S_{x_3} >= 4\hbar\sqrt{P_n^2(+)P_n^2(-)\overline{P}_n(+)\overline{P}_n(-)}\cos\frac{eB}{m}t. \qquad (2.9)$$

We see for small n (initial step), Eq. (2.9) gives us chaotic fluctuations in the $< S_x >$ spin amplitude. We also note that t may define one time scale and n other scale. How they are related could be found from experiment by measuring $< S_x >$ at each t and seeing how it functionally depends on n from Eq. (2.9). It may not be a linear relation although at large n it may converge to a linear relation. We also note from Eq. (2.9) that all 3 fermion composite models of the charged leptons would generate the same form for $< S_x >$ as in Eq. (2.9) as long as two fermions are identical, and flavour, colour and hypercolour degrees of freedom are not present in the 3 preon spin function.

The next model of a charged lepton that we study is actually a version of a 3 preon model developed by Wetterich [33], namely an isodublet of preons with charges $(-2/3, 1/3)(P_1, P_2)$. A charged lepton would be a $P_1P_1P_2$ composite. The problem we have is to develop a composite wave function including spin and flavour. In the first version that we study we borrow from the quark model and choose a symmetric spin–flavour function used for the proton with $\mu = P_1$, $d = P_2$, the spin up state for a charged $-e$ lepton is

$$\Psi_{\uparrow} = \frac{1}{\sqrt{18}}\begin{pmatrix} 2\overset{\uparrow}{P_1}\overset{\downarrow}{P_2}\overset{\uparrow}{P_1} + 2\overset{\uparrow}{P_1}\overset{\uparrow}{P_1}\overset{\downarrow}{P_2} + 2\overset{\downarrow}{P_2}\overset{\uparrow}{P_1}\overset{\uparrow}{P_1} - \overset{\uparrow}{P_1}\overset{\downarrow}{P_1}\overset{\uparrow}{P_2} - \overset{\uparrow}{P_1}\overset{\uparrow}{P_2}\overset{\downarrow}{P_1} \\ -\overset{\downarrow}{P_1}\overset{\uparrow}{P_2}\overset{\uparrow}{P_1} - \overset{\uparrow}{P_2}\overset{\downarrow}{P_1}\overset{\uparrow}{P_1} - \overset{\uparrow}{P_2}\overset{\uparrow}{P_1}\overset{\downarrow}{P_1} - \overset{\downarrow}{P_1}\overset{\uparrow}{P_1}\overset{\uparrow}{P_2} \end{pmatrix} e^{-\mathrm{i}E_+t/\hbar} \qquad (2.10)$$

where $\overset{\uparrow}{P_1}$ is basis function of preon p_1 with spin up, etc. and the spin down state is identical in flavour but with each spin arrow reversed. Equation (2.10) is actually the symmetric SU(6) wave function for the proton with quarks replaced by preons of the Wetterich model. We will assume the breakdown

$$\mathrm{SU(6)} \to \mathrm{SU(3)}_{\mathrm{Flavour}} \times \mathrm{SU(2)}_{\mathrm{Spin}}$$

and actually, as far as Eq. (2.10) is concerned, the wave function only contains the $\mathrm{SU(2)}_{\mathrm{Flavour}}$ subgroup of $\mathrm{SU(3)}_{\mathrm{Flavour}}$. We now assume the two–state Markov process operative for both preon 1(-2/3) and preon 2(1/3). Calling $P_{1_n}(\pm)$ and $P_{2_n}(\pm)$ the 2 state Markov probabilities after n steps for $P_1(-2/3)$ and $P_2(1/3)$, respectively, with initial probabilities at $n = 0$ of $P_{1_0}(\pm 1/2) = P_{2_0}(\pm 1/2) = 1/2$, we can modify Eq. (2.10) to read

$$\Psi_{\uparrow_{e^-}} = \frac{2}{3}\begin{pmatrix} 2\sqrt{P_{1_n}^2(+)P_{2_n}(-)}\,\overset{\uparrow}{P_1}\overset{\downarrow}{P_2}\overset{\uparrow}{P_1} + 2\sqrt{P_{1_n}^2(+)P_{2_n}(-)}\,\overset{\uparrow}{P_1}\overset{\uparrow}{P_1}\overset{\downarrow}{P_2} \\ +2\sqrt{P_{1_n}^2(+)P_{2_n}(-)}\,\overset{\downarrow}{P_2}\overset{\uparrow}{P_1}\overset{\uparrow}{P_1} - \sqrt{P_{1_n}(-))P_{1_n}(+)P_{2_n}(+)}\,\overset{\uparrow}{P_1}\overset{\downarrow}{P_1}\overset{\uparrow}{P_2} \\ - - - - - - - - - - - - \end{pmatrix} e^{-\mathrm{i}E_+t/\hbar}. \qquad (2.11)$$

In Eq. (2.11) we replace each coefficient in Eq. (2.10) by the Markov corrected term, that is

$$-\frac{\overset{\uparrow}{P_1}\,\overset{\uparrow}{P_2}\,\overset{\downarrow}{P_1}}{\sqrt{18}} \to -\sqrt{P_{1_n}(+))P_{1_n}(-)P_{2_n}(+)}\,\overset{\uparrow}{P_1}\,\overset{\uparrow}{P_2}\,\overset{\downarrow}{P_1} \times \frac{2}{3} \quad \text{etc.}$$

($E_\pm = \pm e\hbar B/2m$, $-e$ is charge of lepton, m is mass of lepton).

We find at $n = 0$, Eq. (2.11) reduces to Eq. (2.10). We also construct the spin down state in a similar manner and take the linear combination

$$\Psi = \frac{1}{\sqrt{2}}\Psi_{\uparrow_{e^-}} + \frac{1}{\sqrt{2}}\Psi_{\downarrow_{e^-}}. \tag{2.12}$$

Using Eq. (2.12) to evaluate $< S_{x_1} + S_{x_2} + S_{x_3} >$ $\left(S_{x_1} = \hbar/2 \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} \text{ etc.}\right)$, we obtain

$$< S_{x_1} + S_{x_2} + S_{x_3} >= \frac{2}{9}\frac{\hbar}{2}(2)\cos\frac{eB}{m}t$$

$$\times \begin{pmatrix} -12\sqrt{P^3_{1_n}(+)P_{1_n}(-)P^2_{2_n}(-)} - 12\sqrt{P^3_{1_n}(-)P_{1_n}(+)P^2_{2_n}(+)} \\ +6\sqrt{P^2_{1_n}(+)P^2_{1_n}(-)P_{2_n}(+)P_{2_n}(-)} \end{pmatrix}. \tag{2.13}$$

The variation of the amplitude in Eq. (2.13) is distinctly different than that of Eq. (2.9). We also note that the spin polarization amplitude would vary the same way for "all spin–flavour preon models for e^- generated from a generic SU(6) model independent of the preon charges as long as there are just two flavours in the function of Eq. (2.10)". Another amazing property of Eq. (2.13) is that if spin precession was studied for protons at small n, the fluctuation in the amplitude would be the same as that in Eq. (2.13). This is because the protons spin flavour function is identical to Eq. (2.10) only with $q(P_1) = 2/3$ and $q(P_2) = -1/3$.

If we calculate the magnetic moment of the electron using Eq. (2.10), we find

$$U_{z_{e^-}\uparrow} = \Psi^+(U_1 + U_2 + U_3)\Psi,$$

where Ψ is given by Eq. (2.10), and U_1, U_2, U_3, refer on the magnetic moment operators of the first preon, second preon and third preon. The result is [34]

$$U_{z_{e^-}\uparrow} = \frac{1}{3}(4U_{P_1} - U_{P_2}) = -\frac{e\hbar}{2m_e} \tag{2.14}$$

U_{P_1} is magnetic moment of P_1, U_{P_2} is magnetic moment of P_2.

If we set

$$U_{P_1} = -\frac{2e}{3m_{P_1}}\left(\frac{\hbar}{2}\right),$$

$$U_{P_2} = \frac{e}{3m_{P_2}}\left(\frac{\hbar}{2}\right),$$

we have $-8e/9m_{P_1} - e/9m_{P_2} = -e/m_e$

If $m_{P_1} = m_{P_2} = m$, then

$$-\frac{e}{m} = -\frac{e}{m_e} \text{ and } m = m_e. \tag{2.15}$$

In this case the total bare mass due to constituent preons is $3m_e$. This suggests the internal binding energy is $2m_e$ to generate the effective mass of the electron of m_e.

To exhibit the difference between a SU(6) based model and $\mathrm{SU}(2)_{\mathrm{Spin}}\times \mathrm{SU}(2)_{\mathrm{Flavour}}$ model, we now consider the two preons to have the flavour function [34]

$$\Psi_F = \frac{(P_1P_2 - P_2P_1)}{\sqrt{2}}P_1 \tag{2.16}$$

and the spin function

$$\Psi_S = \frac{1}{\sqrt{2}}(\uparrow\uparrow\downarrow - \uparrow\downarrow\uparrow) \tag{2.17}$$

for spin up.

For spin down we have

$$\Psi_S = \frac{1}{\sqrt{2}}(\downarrow\uparrow\downarrow - \downarrow\downarrow\uparrow). \tag{2.18}$$

If we multiply Eq. (2.16) and Eq. (2.17), we obtain

$$\Psi_\uparrow = \frac{\overset{\uparrow}{P_1}\,\overset{\uparrow}{P_2}\,\overset{\downarrow}{P_1}}{2} - \frac{\overset{\uparrow}{P_1}\,\overset{\downarrow}{P_2}\,\overset{\uparrow}{P_1}}{2} - \frac{\overset{\uparrow}{P_2}\,\overset{\uparrow}{P_1}\,\overset{\downarrow}{P_1}}{2} + \frac{\overset{\uparrow}{P_2}\,\overset{\downarrow}{P_1}\,\overset{\uparrow}{P_1}}{2} \tag{2.19}$$

and for spin down

$$\Psi_\downarrow = \frac{\overset{\downarrow}{P_1}\,\overset{\uparrow}{P_2}\,\overset{\downarrow}{P_1}}{2} - \frac{\overset{\downarrow}{P_1}\,\overset{\downarrow}{P_2}\,\overset{\uparrow}{P_1}}{2} - \frac{\overset{\downarrow}{P_2}\,\overset{\uparrow}{P_1}\,\overset{\downarrow}{P_1}}{2} + \frac{\overset{\downarrow}{P_2}\,\overset{\downarrow}{P_1}\,\overset{\uparrow}{P_1}}{2}. \tag{2.20}$$

In Eq. (2.19) we should multiply by $e^{-\mathrm{i}E_+t/\hbar}$ and in Eq. (2.20) we multiply by $e^{-\mathrm{i}E_-t/\hbar}$ to obtain the total temporal spin–flavour wave function varying with time in an external magnetic field $B_z = B$. We note that Eqs. (2.19) and (2.20) are antisymmetric in flavour for the first and second preons while antisymmetric in spin for the second and third preons. It is noteworthy to point out that in Ref. 34 we demonstrate that specific correlations between preons in the Rishan model generate the correct ratio $\mu_\mu/\mu_d = -2$ for quark magnetic moments to correctly predict the famous relation $\mu_p/\mu_N = -3/2$ for the proton to neutron magnetic moment ratio. It suggests that generation structure might be a manifestation of a specific correlation between preon properties such as spin, flavour, colour and hypercolour [35].

When we evaluate the x component of the spin polarization for a linear combination of Eqs. (2.19) and (2.20), we obtain after inserting the Markov probabilities in the coefficients of Eqs. (2.19) and (2.20)

$$< S_x >=< S_{x_1} + S_{x_2} + S_{x_3} >=$$

$$= \left(\frac{1}{\sqrt{2}} \Psi_\uparrow e^{-\frac{\mathrm{i}E_+}{\hbar}t} + \frac{1}{\sqrt{2}} \Psi_\downarrow e^{-\frac{\mathrm{i}E_-}{\hbar}t} \right) \times$$

$$\times (S_{x_1} + S_{x_2} + S_{x_3}) \left(\frac{1}{\sqrt{2}} \Psi_\uparrow e^{-\frac{\mathrm{i}E_+}{\hbar}t} + \frac{1}{\sqrt{2}} \Psi_\downarrow e^{-\frac{\mathrm{i}E_-}{\hbar}t} \right), \tag{2.21}$$

$$< S_x >= \hbar \cos \frac{eB}{m_e} t \begin{pmatrix} \sqrt{P^3_{1_n}(+) P_{1_n}(-) P^2_{2_n}(-)} \\ + \sqrt{P^3_{1_n}(-) P_{1_n}(+) P^2_{2_n}(+)} \\ +2\sqrt{P^2_{1_n}(+) P^2_{1_n}(-) P_{2_n}(+) P_{2_n}(-)} \end{pmatrix}. \tag{2.22}$$

In Eq. (2.21)

$$\Psi_\uparrow = \sqrt{2} \sqrt{P_{1_n}(+) P_{1_n}(-) P_{2_n}(+)} \underset{P_1}{\uparrow} \underset{P_2}{\uparrow} \underset{P_1}{\downarrow} \; - - - -$$

$$\Psi_\downarrow = \sqrt{2} \sqrt{P^2_{1_n}(-) P_{2_n}(+)} \underset{P_1}{\downarrow} \underset{P_2}{\uparrow} \underset{P_1}{\downarrow} \; - - - - \, . \tag{2.23}$$

It is clear that the signature for how the $< S_x >$ spin polarization varies with n is different in each model. In Eq. (2.9) we have two distinct preons with no flavour degrees of freedom, in Eq. (2.13) we have a spin–flavour model generated from SU(6) that resembles the quark model, and in Eq. (2.22) we have a $\mathrm{SU(2)_{Flavour}} \times \mathrm{SU(2)_{Spin}}$ model with the correlations of spin and flavours mentioned above. In Eq. (2.22) we have the same type of terms as appeared before, only they appear with diferent coefficients.

In an effort to dispense with the hypercolour degree of freedom in the Rishon model, we have constructed a theory of 3 Rishons coupled to a spin 1 and spin 0 boson. The orginal Rishon model [36] has two fermionic Rishons (T, V) of charge 1/3 and 0, respectively. The T Rishons carry colour, the V Rishons carry anti–colour and both T, V Rishons carry hypercolour (the binding force of the Rishons). For quarks it is possible to put 2 similar Rishons in an anti–symmetric colour state, all three Rishons are in totally anti–symmetric hypercolour state and the two similar Rishons can be put in an anti–symmetric spin state so that the total wave function is anti–symmetric for the two similar Rishons to fulfill the requirements of the exclusion principle. However, for leptons it is impossible to satisfy the exclusion principle for fundamental Rishons since all the Rishons are similar and the combination of a totally anti–symmetric colour function (colour singlet) and totally anti–symmetric hypercolour function for a total spin 1/2 (3 particle state) would make it impossible to fulfillthe requirements of the exclusion principle since there is no totally anti–symmetric 3 particle spin state. To remedy this situation, we have constructed a Rishon model of the charged (or uncharged leptons) that does not need hypercolour. It consists of 3 spin 1/2 $\overline{\mathrm{T}}$ Rishons ($q = -e/3$) in a spin 3/2 (symmetric state) and a totally anti–symmetric colour state (colour singlet). In addition, we need a spin 1 boson of charge $-e/3$ and a spin 0 scalar of charge $+1/3$. The spin 3/2 of the 3 fermion combination couples to the spin 1 boson to generate a total spin 1/2 state of the composite fermion. Also angular momentum excitation of the spin 1 boson can produce spin–orbit interaction sufficient to produce the generation structure of the charged leptons. To reproduce the correct magnetic moment of the composite charged leptons, we write for the total magnetic moment of the 3 fermion–spin 1 combination

$$\vec{\mu} = -\frac{e_1}{m_1}\left(\vec{S}_1 + \vec{S}_2 + \vec{S}_3\right) - \frac{e_2}{m_2}\vec{S}_4$$

(1, 2, 3 stand for Rishons of spin 1/2, 4 stands for boson of spin 1). We impose $e_1 = e_2$; $m_1 = m_2$; $e_1/m_1 = e_2/m_2 = e/m_e$ to give

$$\mu_z = -\frac{e_2}{m_2}\left(S_{z_1} + S_{z_2} + S_{z_3} + S_{z_4}\right) = -\frac{e}{m_e}S_{z_{Tot}}. \tag{2.24}$$

The fifth preon (of spin 0) has charge $e/3$, so the total charge is $-e$. To develop the Markov influence on the spin–polarization precession amplitude, we have to write the total function of the four preons. For spin up $S_z = 1/2$ we have

$$\Psi_{\uparrow_{e^-}} = \frac{1}{\sqrt{2}}U^{3/2}_{3/2}V^1_{-1} - \frac{1}{\sqrt{3}}U^{3/2}_{1/2}V^1_0 + \frac{1}{\sqrt{6}}U^{3/2}_{-1/2}V^1_1, \tag{2.25}$$

$$\Psi_{\downarrow_{e^-}} = \frac{1}{\sqrt{6}}U^{3/2}_{1/2}V^1_{-1} - \frac{1}{\sqrt{3}}U^{3/2}_{-1/2}V^1_0 + \frac{1}{\sqrt{2}}U^{3/2}_{-3/2}V^1_1, \tag{2.26}$$

where

$$U^{3/2}_{3/2} = \uparrow\uparrow\uparrow$$

$$U^{3/2}_{1/2} = \frac{1}{\sqrt{3}}(\uparrow\uparrow\downarrow + \uparrow\downarrow\uparrow + \downarrow\uparrow\uparrow)$$

$$U^{3/2}_{-1/2} = \frac{1}{\sqrt{3}}(- - - - -)$$

$$U^{3/2}_{-3/2} = \downarrow\downarrow\downarrow .$$

for the three spin 1/2 (T) Rishons.

Here V^1_0, V^1_1, V^1_{-1}, refer to the S_z basis functions for the spin 1 preon (charge is $-e/3$). When Eqs. (2.25) and (2.26) are modified to take into account Markov environmental processes, we arrive at a formula for the spin polarization amplitude depending on the two probabilities for the spin 1/2 Rishons and actually 6 Markov probabilities for the spin 1 preon since they depend on whether spin 1 correlates with a $S_z = \pm 3/2$ or $S_z = \pm 1/2$ state of the three spin 1/2 Rishons. The calculations involved in this model are lengthy and we discuss them in another note. The essential difference between this model and the usual Rishon model for charged leptons is that by eleminating hypercolour, we consider additional preons of spin 1 and 0.

3. Conclusion

We have seen in Eqs. (2.9), (2.13) and (2.22) that depending on whether or not flavour admits an SU(2) symmetry and can be included in a higher rank group (SU(6)), the spin polarization amplitude depending on n takes on different functional values. Another probe to Markov effects along with a test for specific composite structure of the electron lies in the fact that if the flavour symmetry of the preons for the electron is expressed by Eq. (2.10), then the proton and the electron should exhibit similar (small time) chaotic fluctuations in $< S_x >$. Although we calculated $< S_x >$ for one other spin flavour model beyond the model described by Eq. (2.12), all SU(2)×SU(2) spin flavour models would have the same form for the spin polarization amplitude as that expressed in Eq. (2.22) with the possibility of different numerical coefficients for the terms in Eq. (2.22). The details of these calculations will be discussed in another note. Lastly, the modified Rishon model with a spin 1 boson will also produce specific signatures for short time variations of the spin polarization amplitude. From an experimental point of view, probing the short time variation of $< S_x >$ could be attained by passing an already polarized beam of leptons in the x–direction into a z–component magnetic field. The appearance of small time fluctuation in the amplitude of $< S_x >$ could be followed by secondary effects that the spin polarization of e^- produces. An example would be the interaction with a polarized anti–neutrino beam that in turn produces w^- (to decay into quark and leptons). Since only a left handed e^- could produce the w^-, we would expect a peak in the decay products of w^- when $< S_x >$ is opposite to the motion of the e^- beam.

In closing, the experimental mass splitting of the baryons predicted by the SU(6) quark model [10] was one of the greatest achievements of twentieth century physics. It might also be that lepton and quark composites might also be discovered through an innovation such as short time variations of the spin polarization precession in a z–component magnetic field.

Certainly, the present search for lepton and quark compositeness has only produced limits using anomalous moments, rare decays and form factors [37], whereas a technique such as spin polarization precession in a "Penning trap" [38] might not only produce limits but also clear and distinct yes–no signatures for compositeness.

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KRITERIJI ZA RAZLIKOVANJE MODELA LEPTONA MJERENJEM PRECESIJE SPINA ČESTICE

Razmatra se niz složenih modela za električki nabijene leptone i pokazuje da se, pod utjecajem smetnje uzrokovane Markovljevim procesom u jakom magnetskom polju, mogu izvesti kriteriji za razlikovanje modela mjerenjem precesije spina čestica.