A phenomenological magnetic description for the origin of mass for leptons and for the complete baryon octet

Osvaldo F. Schilling

Departamento de Física, Universidade Federal de Santa Catarina, Campus, Trindade, 88040-900, Florianópolis, SC. Brazil

Email: osvaldo.neto@ufsc.br

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Abstract

A.O.Barut in the late 1970s put forth an alternative theory for the inner constitution of baryons and mesons, in which the basic pieces would be the stable particles, namely the proton, the electron, and the neutrino, rather than quarks with fractionary charges. At the same time Barut proposed also that the short range strong interactions between such internal constituents would be magnetic in nature. Quite recently, in vixra 1511.0005, we developed a phenomenological model based upon the concept that the magnetodynamic energy of zitterbewegung intrinsic motion is the source for the rest energies, and therefore, the source of mass in particles. In the present paper we show that assuming Barut´s ideas are correct, our recently proposed model can be applied to leptons and to the full baryon octet with almost perfect accuracy. It is shown that mass for all these particles depends on two quantities, namely, the number of magnetic flux quanta trapped in an intrinsic vibrational motion, and the magnetic moment of the particle.

Introduction

This paper builds upon the recent work by the author, vixra 1511.0005[1], which should be consulted for details. In that paper, beginning from the concept of gauge invariance and accepting as true the zitterbewegung intrinsic motion of fundamental particles, as discussed by Barut and Bracken[2] among others, we associated the magnetodynamic energy of the motion with the rest energy of a particle. The main result of such analysis was eq. (3) of [1]:

$$\frac{mR^2}{\mu} = \frac{nh}{2\pi ec} \tag{1}$$

In this equation m is mass, R is the range of the vibrational intrinsic motion of the particle, μ is the magnetic moment, n is the number of magnetic flux quanta(admitted as given by the nonrelativistic expression hc/e). The model adopts experimental values for m and μ. For the nucleons R was given by theoretical values calculated by Miller[3], and for the electron (and now the muon) this parameter was assumed as equal to the Compton wavelength $\lambda = \hbar/mc$[2]. Good agreement between model and experiment was obtained for that reduced group of particles.

However, the application of the model to other particles depends on the knowledge of the parameter R. In order to put the model to further test, in the present work we decided firstly to simply try and eliminate the explicit dependence of the model upon R. For the leptons the following expression is known to be valid:

$$\mu = e\lambda/2 \tag{2}$$

Here $\mu = \mu_B$ is the magnetic moment in the case of the electron (μ_B is the Bohr magneton; here we consider no further corrections). Therefore, for the remaining members of the baryon octet considered in this work we will *assume* that in (2) $\lambda/\sqrt{2}$ can be directly replaced by R, so that R is eliminated from (1) in favor of μ. It is clear that such possiblity associates mass to only two parameters, namely, the number of flux quanta imposed by gauge invariance conditions and the charges of the constituents inside the baryons, and to the inverse of the experimental magnetic moment. As shown below we verify that such proposal is consistent with experiment.

Inserting the definion for *R* into (1) and using the definition of the fine structure constant $\alpha = e^2/\hbar c$ (which we assume as 1/137) we can rewite (1) in the form:

$$\frac{2c^2\alpha}{ne^3} m = \frac{1}{\mu} \tag{3}$$

Application of Barut´s model of matter

A.O.Barut in the late 1970s[4,5] put forth an alternative theory for the inner constitution of baryons and mesons, in which the basic pieces would be the stable particles, namely the proton p, the electron e^-, and the neutrino ν(primes will indicate antineutrinos, below), rather than quarks with fractionary charges(as assumed by us in [1]). At the same time Barut proposed also that the short range strong interactions between such internal constituents would be magnetic in nature. In the present paper we show that assuming Barut´s ideas are correct, our recently proposed model can be applied to leptons and to the full baryon octet with almost perfect accuracy. The values of *n* , the number of flux quanta in (3), are calculated for each particle from their compositions, following the proposals of Barut in [4,5]. In order to account for the same conservation rules as a model based upon the fractionary quarks does, the constitution of baryons should be as follows[4,5]: proton =p= (p e^- e^+), neutron=n= (p e^- ν'), Σ^- =(p e^- μ^- ν ν'), Σ^0 =(p μ^- ν'), Σ^+ =(p e^+ μ^-), Ξ^- =(p μ^- μ^- ν $'\nu'$), Ξ^0 =(p μ^- e^+ ν $'$), Λ =(p μ^- ν ν $'\nu'$). We see that the proton is present in all baryons but itself is a composite particle, supposedly containing an electron and a positron.

In a previous (unpublished) calculation based upon an average over the three different quarks spins configurations weighted by their Clebsch-Gordan coefficients, we obtain *n*=3 flux quanta for a proton. For the other baryons listed above we add one unit for each positive extra charge in the respective composition, and subtract one unit for each negative charge. Table 1 displays the values of *n* and the other data utilized in the analysis. The magnetic moment data are from [6].

Analysis

Figure 1 shows the plot of eq.(3) and the straight solid line would indicate perfect agreement with theory. We observe the following:

1) Equation (3) describes perfectly well the data available for leptons (triangles) and baryons, except the neutral sigma and xi baryons, which yet stay within a factor of two distance from the solid line as shown by the dotted lines in the plot of Figure 1.

However

2) The quantization rules adopted in this model[1] clearly correspond to a nonrelativistic limit. Such rules certainly depend on other symmetry properties of these particles associated with the SU(3) group, for instance. Such details lay beyond the scope of this treatment.

Our previous(in version 1) attempt of assuming that baryons are formed by combinations of quarks was less successful in fitting the model to the experiments. Barut´s model has allowed mass to be interpreted as a magnetic property for all these apparently uncorrelated particles (leptons and baryons).

There exists a wealth of references in the literature in which scaling laws are proposed based[7-9] on experimental results, to associate mass for all particles with the inverse of α. We see from (3) that such relation with α indeed is part of our results. In particular, the results of [9] might be reproduced if the ratio n/μ in (3) is made part of the *free* parameter N in ref. [9].

In resume, this paper has shown that if one properly inserts quantum conditions in a closed-orbit intrinsic motion for the fundamental particles (even in a nonrelativistic limit), in order that gauge invariance is introduced in the treatment, the masses for these particles are directly dependent only upon the inverse of their magnetic moments and upon the number of magnetic flux quanta inside the orbits. Barut´s model for the constitution of matter results in that no other parameters seem necessary in order to obtain a satisfactory agreement between this theory and experiment.

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Table 1: Data utilized in Figure 1. The magnetic moments are from ref. [6]. One needs to convert mass to grams, magnetic moments to erg/gauss (all CGS units).

part	Rest energy(MeV)	n	(Abs)Magnetic moment(n.m.)
e	0.511	1	1836
muon	105.66	1	8.89
p	938.27	3	2.79
n	939.56	2	1.91
$\Sigma +$	1189	3	2.46
$\Sigma 0$	1192	2	0.85
$\Sigma -$	1197	1	1.16
$\Xi 0$	1314	2	1.25
$\Xi -$	1321	1	0.65
Λ	1116	2	0.61

Figure 1: Plot of eq. (3). The dotted lines indicate a factor of 2 around the solid line. Triangles are leptons and circles are baryons.