# Coherence between Magnetic charge and 70 MeV mass quanta of Hadrons

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## 1. Introduction

In this contribution the authentication of the comprehensive constituent quark model exhibiting the 70 MeV mass quanta involved in hadron spectroscopy has been outlined with respect to the existence of magnetic charge. The light meson spectra available from Particle Data Group-2008 listings [1] has being viewed to display Zeeman splitting upon scrutiny of the non-Regge spacing with J~M . Evidence of L-S coupling is derived for the meson states satisfying the Lande's interval rule and susequently the involvement of magnetic interactions is displayed leading to subsistence of magnetic monopole.

## 2. Subsistence of magnetic charge in Meson states

Constant efforts are made by physicists to prove the existence of magnetic monopole predicted by Dirac. There have been proposals by Schwinger and others [2-5] that quarks may consist of both electric and magnetic charge. It was suggested [6] that magnetic charge of spin J= 0 may exist internal to the quarks and generate magnetic fields among the meson states. Evidence of magnetic charge in scattering experiments was also given [7] to account for residual strong interaction effects. There is evidence [8] that a low mass magnetic monopole of Dirac charge g=(137/2)e may be Zeeman-splitting meson states. A quantum mechanical derivation of the Zeeman effect for an electric charge – magnetic monopole system has also been given [9]. In hadron spectroscopy, Zeeman splitting is possible in the presence of magnetic charge. All these findings further strengthens the idea of the possible existence of magnetic charge in hadronic structure. In the present work we have shown the presence of Zeeman splitting among the meson states by plotting non-Regge spacing with J~M for low mass mesonic data available from Particle Data Group listings 2008 [1]. Here we have applied the Russell-Saunders coupling scheme [10] to the quarks in light meson spectroscopy. Keeping in mind the fact that mesons, composite of quark-antiquark pairs are extensively studied as quarkonium and have been compared to positronium like bound states, the physics of the atomic scale has been applied to particle scale [6]. Therefore splitting is expected in P-states of meson system, with $3P_1$ states splitting into 3 separate levels, and with $3P_2$ states splitting into 5 separate levels in the presence of magnetic field. We have examined the experimental evidence of P-level splitting in the light meson systems.

**Table 1:** Calculations of the mass splitting for P-states (J=2) associated with mesons

| Calculation of Lande Interval | Lande Ratio |
|---|---|
| Upper states: $\frac{[f_2(1640)-f_2'(1525)]}{[f_2(1565)-f_2'(1525)]}$ | 2.8 |
| Lower states: $\frac{f_2'(1525)-a_2(1320)]}{f_2'(1525)-f_2(1430)]}$ | 2.1 |
| Upper states: $\frac{[f_2(2010)-f_2(1910)]}{[f_2(1950)-f_2(1910)]}$ | 2.5 |
| Lower states: $\frac{[f_2(1910)-a_2(1700)]}{[f_2(1910)-f_2(1810)]}$ | 2.1 |
| Upper states: $\frac{[f_2(2380)-f_2(2300)]}{[f_2(2340)-f_2(2300)]}$ | 2.0 |
| Lower states: $\frac{[f_2(2300)-f_2(2150)]}{[f_2(2300)-f_2(2220)]}$ | 1.9 |

Thus the evidence of L-S coupling is derived from the light meson spectra. If these spectra are shown to satisfy Lande interval rule, which is widely used in atomic molecular and nuclear physics it gives support to the L-S coupling. For the P-state (J=2) the Lande interval rule predicts a mass splitting or ratio of 2.0 for the states within the same multiplet. We have calculated Lande ratio for these mass splitting (Table 1).

Though the mass splitting can be due to various effects such as Zeeman effect, Paschen back effect and also Stark effect but here we are interested in the effect which is due to the magnetic field and as mentioned earlier there are several evidences to believe that Zeeman effect is responsible for splitting of states, for lifting the degeneracy of P-states and for generating distinct particles.

The expression for energy in the Zeeman or Paschen Back splitting of the meson states is given by the relation:

$$\Delta E = g m_j \mu B$$

Where g is Lande factor, μ is the magnetic dipole moment of the quark and B is the magnetic field which would have been generated because of the presence of magnetic charge inside the quarks. The individual quark's magnetic moment would then interact with the field B. It is speculated [11] that typical magnetic interactions are of 50 MeV depending upon the rms radius of the charge distribution for the mesons (r~0.6 fm).

## References

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