

Substantiation of Meson mass quantization from phenomenological Regge Trajectories

Navjot Hothi^{1*} and Shuchi Bisht²

¹Department of Physics, University of Petroleum and Energy Studies, Dehradun – 248007, INDIA

²Department of Physics, Kumaun University, Nainital- 263002, INDIA

* email:hothi.navjot@gmail.com

1. Introduction

Quark mass quantization is a revolutionary concept [1] and the present contribution provides a validation to it. A better understanding of the hadron dynamics is viable once quantization becomes evident. The derivation of quark masses from Barut’s solution to relativistic Balmer formula provides a basis for calculating quark masses for mesons and baryons from the experimental hadronic RTs for Particle Data Group 2014 listings [2]. Astoundingly, the quark masses calculated from this approach are very close to the earlier proposed 70 MeV mass quanta. This in itself is substantiation to the proposal of quantized hadronic masses, which will ultimately prove to be very useful in unraveling the mysteries of hadron dynamics.

2. 70 MeV mass quanta: The Ultimate Mesonic building block

Gregor observed [3,4] that the hadron spectrum shows regularity with energy separations in the units of 70 MeV. He proposed that quarks are light and have small binding energies. These small binding energies of quarks leash two types of quanta. The first one is a 70MeV spinless quanta Q, which reproduces the pion and the second one is a 330MeV spin 1/2 quanta S, which reproduces the nucleon. The second quanta is basically a derivate of the original 70 MeV mass quanta. This 70MeV spinless mass quanta of Gregor [3-5] can be undoubtedly derived from the electron mass and the fine structure constant as

$$Q = m_e / \alpha = 70 \text{ MeV}$$

Also, the Nambu empirical mass formula:

$$m_n = (n/2) 137 m_e \quad (n \text{ is a positive integer})$$

which can tabularize the particle spectrum is candidly related to this particular quantum.

We know that $\pi = Q\bar{Q}$, where Q and \bar{Q} are ~70MeV light mass quanta. In the similar fashion, K meson is 7Q that is seven times the mass quantum Q. The other mesonic resonances which are exact multiple of 70 are:-

- 1) $\rho(770)$ 2) $a_0(980)$ 3) $\pi_2(2100)$ 4) $a_6(2450)$
5) $K_1(1400)$ 6) $K_2(1820)$ etc.

The subsistence of the 70 MeV boson was also stemmed from the mass of the classical Dirac Magnetic Monopole [6]. Further, the sequel [7] of the previous reference provides testimony of this quanta from the findings of the Particle Data Group listings [8]. Furthermore, according to Gregor, all particles more massive than the electron can be constructed from a single mass quantum Q.

3. Relativistic Balmer formula and Meson quark masses

In case of mesons, the pion is the lowest mass meson and thus the starting member of the meson RT. The pion is composed of two 70 MeV/c² mass quanta. From Barut’s solution to a relativistic Balmer mass formula,

$$M^2 = (m_1 + m_2)^2 + 2m_1 m_2 J / \alpha$$

If $m_1 = m_2 = m$, then

$$\text{Slope} = \frac{2m^2}{\alpha}$$

and

$$m = \sqrt{\frac{\text{Slope} \alpha}{2}}$$

Table 1 displays the quark mass for each trajectory along with the deviation from standard value of 70 MeV for Mesonic Regge Trajectories. From the table it is evident that the deviation from the standard values is very low and profoundly the experimental quark masses match very distinctly with the theoretical postulation of the 70MeV mass quanta. The reason for slight deviation from the exact

quantized masses has been explained in the next section.

Table 1: Calculated values of quark masses for several series of Mesonic Regge Trajectories

S. No	Hadrons		Slope	Quark mass
1	Unflavored u-d mesons	1	0.849	55MeV
		2	0.885	56MeV
		3	1.056	62MeV
		4	1.088	63MeV
2	Unflavored u-d mesons	1	0.726	51MeV
		2	0.928	58MeV
		3	1.227	66MeV
3	Unflavored u-d mesons	1	0.697	50MeV
		2	0.989	60MeV
4	Unflavored u-d mesons	1	0.909	57MeV
		2	0.935	58MeV
5	K mesons	1	0.856	55MeV
		2	1.145	64MeV
		3	1.187	65MeV

4. Factors leading to deviation of quark masses from the 70 MeV mass quanta

Several features evidently cause the deviation of masses of hadrons from the integral multiples of 70 MeV mass quanta. Coulomb corrections and spins are prominent contributory factors along with magnetic moment ratios and charge splitting. Another responsible factor could be the strangeness quantum number. Constituent quark binding energies is also one of the factors leading to variation in mass. Furthermore, the constituent quark binding energies also reduces the masses of hadrons by nearly about 3 to 4% [3, 9]. The relativistically spinning configuration of rotating masses also leads to deviation of masses of hadrons from the integral multiples of seventy.

References

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