RESEARCH NOTES

A NOTE ON MASS FORMULA AND QUARK STRUCTURE

T. ROY

Department of Physics
Jadavpur University
92, Regent Estate
Calcutta - 700092, INDIA

(Received November 12, 1987)

ABSTRACT. A simple proof of the Gelmann-Okubo mass formula for the baryon octet and decuplet is given in this note.

KEYS WORDS AND PHRASES. Gelmann-Okubo mass formula.

1980 AMS SUBJECT CLASSIFICATION CODE. 81G.

1. INTRODUCTION.

The quark structure of Baryons were taken seriously and their magnetic moments were obtained by Thirring [1]. Here we will show how easily and trivially one can find the mass formula for the octets and decuplets. Following Levisetti [2], we have

$$3 \quad 3 \quad 3 = 1 + 8 + 8 + 10 .$$

We need only consider the octets and decuplets.

The quark structure of octets are as follows

$$\begin{array}{ll} p = uud & n = udd \\ \Lambda = usd & \Sigma^+ = uus \\ \Sigma^0 = uds & \Sigma^- = dds \\ \Xi^0 = uss & \Xi^- = dss \end{array}$$

Thus,

$$p + n + \Xi^0 + \Xi^- = 4u + 4d + 4s$$

Also

$$\Sigma^+ + \Sigma^0 + \Sigma^- + \Lambda = 4u + 4d + 4s$$

Hence

$$\frac{2N + 2\Xi}{4} = \frac{3\Sigma + \Lambda}{4}$$

This is the mass formula for the octet.

Now, we consider the decuplets

$$\begin{array}{lll}
\Delta^{++} = uuu & \Delta^+ = uud & \Delta^0 = udd \\
\Delta^- = ddd & Y_1^{*+} = uus & Y_1^{*0} = uds \\
Y_1^{*-} = dds & \Xi^{*0} = uss & \Xi^{*-} = dss \\
\Omega^- = sss
\end{array}$$

Thus

$$\Delta = \frac{\Delta^{++} + \Delta^+ + \Delta^0 + \Delta^-}{4} = \frac{3}{2} (u + d)$$

$$Y_1^* = \frac{Y_1^{*+} + Y_1^{*0} + Y_1^{*-}}{3} = s + (u + d)$$

$$\Xi^* = \frac{\Xi^{*0} + \Xi^{*-}}{2} = 2s + \frac{(u + d)}{2}$$

$$\Omega^- = 3s$$

It turns out that

$$Y_1^* - \Delta = s - \frac{(u + d)}{2}$$

$$\Xi^* - Y_1^* = s - \frac{(u + d)}{2}$$

$$\Omega^- - \Xi^* = s - \frac{(u + d)}{2}$$

That is, they are equally spaced so that

$$Y_1^* - \Delta = \Xi^* - Y_1^* = \Omega^- - \Xi^*$$

This is the decouplet mass formula. We may call this the Gellmann-Okubo [2, p. 50] mass formula for the baryons.

REFERENCES

1. THIRRING, W. Acta Physica, Austriaca Supplement II, 1966, p. 183.
2. LEVISETTI, R., et al. Strongly Interacting Particles, (University of Chicago Press) 1973, eqn. 5.48, p. 44.