A VARIANT OF HYPERON THEORY

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WE shall assume as the basis of our discussion the hyperon model proposed by Goldhaber[1] and D'erdi[2] representing hyperons as compound particles consisting of nucleons and $\overline{K}$-mesons, bounded together by forces dependent on the isotopic spin. Under certain assumptions given below this model yields a relation connecting the masses of the nucleon (N) and of the hyperons Λ, Σ, and Ξ.

$$2M_{\Xi} + 2M_N = 3M_{\Lambda} + M_{\Sigma}, \tag{1}$$

which is satisfied better (8846 and 8880) than another relation obtained by Gell-Mann[3] from different considerations:

$$2M_{\Xi} + 2M_N = M_{\Lambda} + 3M_{\Sigma}, \quad (8846 \text{ and } 9185). \tag{1a}$$

The model considered below permits us also to draw conclusion about hyperons with strangeness -3 and larger in the absolute value.

We shall assume the following relation for hyperons with strangeness $S = -1$

$$M = M_N + M_K + c + a(t_N t_K) = M_N + b + a(t_N t_K), \tag{2}$$

where a, b, c are constants and the parentheses contain the scalar product of isotopic spins of the bound particles. Comparing this expression with the data concerning the Λ-particle [$t = 0$ and therefore $(t_N t_K) = -3/4$, $M_\Lambda = 2182$] and the Σ-particle [$t = 1$ whence $(t_N t_K) = 1/4$, $M_\Sigma = 2334.5$] we find that $a = 152.5$, $b = 459.5$, and $c = -506$ (electron mass has been taken as 1).

For the hyperon with $S = -2$, consisting of a nucleon and two $\overline{K}$-particles, it is logical to take as a first approximation

$$M = M_N + 2b + a(t_N t_{2K}), \tag{3}$$

where a, b are identical with the constants of Eq. (2).

The following assumptions are implicit in the above: (1) the interaction between $\overline{K}$-particles is small compared with the interaction between a $\overline{K}$ and a nucleon, and (2) in a hyperon with $S = -2$ the two $\overline{K}$-particles are in the same state, identical to that of a single $\overline{K}$ in a hyperon with $S = -1$.

Since $\overline{K}$-particles are bosons it follows from the second assumption that the isotopic spin of a system consisting of two $\overline{K}$-particles can equal only 1 (and not 0). Consequently, two charge multiplets are possible in the above scheme for $S = -2$: (1) the multiplet $t = 1/2$, $(t_N t_{2K}) = -1$, representing a particle for which formula (3) yields a mass of 2603 in a good agreement* with the experimental value for the mass of equal to 2586, and (2) the multiplet (denoted by A in the following) $t = 3/2$ with an expected mass 2832.

Reaction \ Strangeness	-1 (Λ)	-2 (Ξ)	-3 (B)	-4	-2 (A)
$\pi + N = X + rK$	0.75	2.2	4.2	6.8	2.55
$N + N = X + rK + N$	1.6	3.8	6.5	9.6	4.15

D'erdi[2] predicted qualitatively, without any mass estimate, the existence of the multiplet $S = -2$, $t = 3/2$, heavier than Ξ, and analysed its properties as a function of the difference between the masses of A and Ξ. The other multiplet predicted by D'erdi, with $t = 1/2$ (beside the Ξ-particle), cannot exist since $\overline{K}$-particles are bosons.

It follows from the formula that $M_A - M_\Xi = 229 < m_\pi$. This result, however (upon which depends the possibility of detection of the tracks of A^+ and of the doubly charged A^{--}), cannot be regarded as firmly established.

If the agreement between the mass of Ξ and the value predicted by the formula is not accidental, it follows from the above considerations that the hyperon family can be extended to large (absolute) values of S. An isotopic spin $t = (r - 1)/2$ and mass $1761 + 421r$ should correspond to strangeness $S = -r$.

The hyperons Λ $(r = 1)$ and Ξ $(r = 2)$ belong to this group. The nucleons $(r = 0)$ and the Σ-particle $(r = 1)$ belong to the second group, for which $t = (r + 1)/2$ and mass equals $1837 + 497.5r$. Instability occurs soon in this group for $r = 2$ or 3, leading to fast π-meson decay:

The production thresholds in Bev (in the laboratory frame) for hyperons of the frist group with various S and for A (belonging to the second group) are given in the table. The hyperon of the first group with $S = -3$ and isotopic spin 1, denoted in the table by B, should exist in three charge states: B^0, B^-, and the doubly charged B^{--}.

If the expressions for the masses given above are at least approximately correct, then the hyperons of the first group, including B, cannot disintegrate by emission of $\overline{K}$-mesons and, therefore, are metastable cascade particles. Production of such particles is not very probable and would require great energies, but their detection does not present special difficulties.

A simple additivity of the $\overline{K}$-meson-nucleon interactions requires that the $\overline{K}$-mesons in hyperons are in the s-state in the nucleon field.

The above considerations, therefore, are correct only if the geometrical spin of all hyperons equals ½ and if they all have even parity in a system in which nucleons and $\overline{K}$-mesons are even. It should be noted that such parity excludes the treatment of K-particles according to Fermi-Young theory as $(\Lambda + N)$.[4,5]

In the language of field theory, the proposed scheme corresponds to an interaction term in the Hamiltonian, containing the square of the absolute value of the nucleonic wave function and the square of the absolute value of the $\overline{K}$-meson wave function. It differs in this from the scheme proposed by Wentzel[6] which introduces the interaction as linear in the K-meson wave function and, therefore, has to consider the hyperon Λ, together with the nucleons and the K-meson as an elementary particle.

*This agreement is equivalent to validity of Eq. (1), since

$$M = M_N + 2b - a, \quad a = M_\Sigma - M_\Lambda, \quad b = \frac{3}{4}M_\Sigma + \frac{1}{4}M_\Lambda - M_N,$$

from which Eq. (1) follows elementarily.

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[3] M. Gell-Mann, Phys. Rev. (1957) (in print).

[4] M. A. Markov, О систематике элементарных частиц (Classification of Elementary Particles), Acad. Sci. Press, 1957.

[5] R. W. King and D. C. Peaslee, Phys. Rev. **106**, 360 (1957).

[6] J. Wentzel, Helvetica Physica Acta **30**, 135 (1957).

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171

MAGNETO-VORTEX RINGS

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IN Ref. 1 we considered magnetohydrodynamical equilibrium configurations. It was noted that the distribution of the field H and the current density j in those configurations is identical with the distribution of the velocity v and vorticity Ω, corresponding to the stationary flow of an incompressible fluid.

Chandrasekhar[2] paid attention to the existence and showed the stability of the simplest solution of the magnetohydrodynamical equations of an incompressible, perfectly conducting fluid, for the case where the