The interchanges*

$$\psi_2 \to -i\psi_2, \quad \chi \to \varphi, \quad g_\chi \to g_\varphi, \quad f_\chi \to -f_\varphi$$

bring the expression (6) to the form (5), and the interchanges

$$\psi_2 \to -i\psi_2, \quad \xi \to \phi, \quad g_\xi \to g_\phi, \quad f_\xi \to f_\phi$$

bring (8) to the form (7). Thus there are two types of Lagrangians of the second kind, namely (5) and (7), and the type of interaction is determined by the behavior of the boson field operator under the operation P.

As has been shown by Pais and Jost,[2] the requirement of invariance under C forbids the combination of the scalar and vector couplings for scalar particles. This is true, however, only for interactions of the first class; as can be seen from Eq. (5), a combination of scalar and vector couplings is possible for interactions of the second class.

Following the hypothesis put forward by the writer,[3] let us consider strong interactions invariant with respect to T, but possibly non-invariant with respect to P. As has been shown in Ref. 4, interactions of the second class contain terms in which the parity is not conserved, but isotopically invariant interactions of the first class without gradient coupling do not contain such terms.

In view of the possibility of the replacements $\psi_2 \to -i\psi_2$ and so on, there is only one form of Lagrangian of the second class that is invariant with respect to T, namely (gradient terms are omitted):

$$L = g(\bar{\psi}_1\gamma_5\psi_2\phi + \bar{\psi}_2\gamma_5\psi_1\phi^*) + ig'(\bar{\psi}_1\psi_2\phi - \bar{\psi}_2\psi_1\phi^*). \qquad (9)$$

We note that the Lagrangians of the first class invariant with respect to T will be different for the operators φ and ϕ.

Since the behavior of the π-meson field under the transformation T is known, the terms of the interaction Lagrangian of baryons and mesons belonging to the first class are completely determined, and there exists only one form for the interaction of the second class. Therefore the isotopically invariant Lagrangian of the strong interaction of baryons and mesons, invariant with respect to T, is uniquely determined. The part of this Lagrangian invariant with respect to P has been given in Ref. 1, and the other part in Ref. 4.

*My attention was called to the possibility of this sort of replacements by Chzhou Guan-Chzhao, to whom I express my gratitude.

[1] A. Salam, Nuclear Phys. **2**, 173 (1956).
[2] A. Pais and R. Jost, Phys. Rev. **87**, 871 (1952).
[3] V. G. Solov'ev, J. Exptl. Theoret. Phys. (U.S.S.R.) **33**, 537 (1957), Soviet Phys. JETP **6**, 419 (1958).
[4] V. G. Solov'ev, J. Exptl. Theoret. Phys. (U.S.S.R.) **33**, 796 (1957), Soviet Phys. JETP **6**, 613 (1958).

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270

ON THE SYSTEMATICS OF MESONS AND BARYONS

H. OIGLANE

Institute of Physics and Astronomy, Academy of Sciences, Estonian S.S.R.

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In a paper by the writer[1] a classification of baryons has been given on the basis of two quantum numbers — the third component of the isotopic spin, t_3, and the third component of the so-called isotopic moment, v_3. The results obtained can be represented as shown in Table I.

TABLE I

Type of baryon	p	n	Ξ^0	Ξ^-	Σ^-	Σ^0	Σ^+	Ω^-	Λ^0	Z^+
t_3	$-\frac{1}{2}$	$+\frac{1}{2}$	$-\frac{1}{2}$	$+\frac{1}{2}$	1	0	-1	0		
v_3	$-\frac{1}{2}$		$+\frac{1}{2}$		0			1	0	-1

In order to obtain the analogous scheme for the mesons, one must set up the irreducible equations for the multiplets of free bosons.

We note that from the equation

$$[\beta_\nu \partial / \partial x_\nu + k_0 \exp(a\eta_5)]\psi = 0 \qquad (1)$$

there follows the ordinary second-order wave equation. Here β_ν and η_ν are the Kemmer-Duffin matrices,[2] a is a constant, and

$$\eta_5 = \eta_1\eta_2\eta_3\eta_4. \qquad (2)$$

Equation (1) is a generalization of the Proca-

Kemmer-Duffin equation. But for reasons that have been considered by the writer in Ref. 3, Eq. (1) is not useful for the description of multiplets of particles.

Let us generalize Eq. (1) in the following way:

$$[B_\nu \partial / \partial x_\nu + k_0 I \exp(aT_3)]\,\psi = 0. \tag{3}$$

Here the operators B_ν, I, and T_3 satisfy the commutation relations

$$B_\nu B_\rho B_\sigma + B_\sigma B_\rho B_\nu = \delta_{\nu\rho} B_\sigma + \delta_{\sigma\rho} B_\nu,$$
$$B_\nu T_3 + T_3 B_\nu = 0, \qquad I T_3 + T_3 I = 0,$$
$$I B_\nu - B_\nu I = 0. \tag{4}$$

For these operators we can choose the following irreducible representation (notations of Ref. 3):

$$B_\nu = 1^{\mathrm{II}} \times \beta_\nu, \qquad T_3 = \sigma_3 \times \eta_5,$$
$$I = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} \times 1^{\mathrm{V}}. \tag{5}$$

With the choice (5), Eq. (3) describes isotopic spin multiplets of free mesons.

In complete analogy with the case of the fermions,[1] we can introduce here also the isotopic moment operator V_3. Then the mesons will be characterized by the quantum numbers shown in Table II.

TABLE II

Type of meson	K^+	$K^{\bullet}$	K^0	K^-	π^-	$\pi^{\bullet}$	π^+
t_3	$-\frac{1}{2}$	$+\frac{1}{2}$	$-\frac{1}{2}$	$+\frac{1}{2}$	1	0	-1
v_3	$-\frac{1}{2}$		$+\frac{1}{2}$		0		

It is interesting to note that the system of mesons coincides completely with the system of baryons; the only thing absent is the isotopic-moment triplet corresponding to the baryons Ω^-, Λ^0, Z^+.

The electric charges of baryons and mesons are expressed by a common formula

$$q = -e(t_3 + v_3). \tag{6}$$

A study of the experimental material[4] gives the following rules: (a) In the strong and electromagnetic interactions there is conservation of both the third component of the isotopic spin and also the third component of the isotopic moment of the system (the electric charge is of course also conserved). (b) In the weak interactions only the charge of the system is conserved, since the third component of the isotopic spin and the third component of the isotopic moment change by $\pm\frac{1}{2}$. All processes that do not satisfy these rules are forbidden.

[1] H. Oiglane, J. Exptl. Theoret. Phys. (U.S.S.R.) **33**, 1537 (1957), Soviet Phys. JETP **6**, 1189 (1958).

[2] W. Pauli, Relativistic Theory of Elementary Particles (Russian translation), Moscow, 1947.

[3] H. Oiglane, J. Exptl. Theoret. Phys. (U.S.S.R.) **33**, 1511 (1957), Soviet Phys. JETP **6**, 1167 (1958).

[4] L. Okun', Usp. Fiz. Nauk **61**, 535 (1957).

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271

CONCERNING AMBIPOLAR DIFFUSION IN A MAGNETIC FIELD

A. V. NEDOSPASOV

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THE basic characteristics of the low-voltage arc region are determined by ambipolar diffusion both in radial and axial directions, from the region of the cathode spot.[1,2] If the low-voltage region is placed in a homogeneous longitudinal magnetic field of intensity H, the distribution of electron concentration of the current on the wall, and also the dimensions of the low-voltage region, change with the ratio $D_\parallel / B_\perp$ of the diffusion coefficients parallel and perpendicular to the magnetic field. This makes it possible to determine the value of the above ratio for various values of H. In particular, the ion current on the wall varies, within a certain range of z, in accordance with

$$j_w = c \exp\left(-\frac{\mu_1 z}{r_0}\sqrt{\frac{D_\perp}{D_\parallel}}\right), \tag{1}$$

where r_0 is the radius of the tube, z the coordinate along the tube axis, and μ_1 the eigenvalue of the boundary problem, which can be determined from measurements at H = 0.

The author, helped by G. I. Pankova, measured the distribution of the ion-current density on the walls, in the low-voltage arc region, at various values of H. The measurement procedure was analogous to that described in Ref. 2. The general pattern of the observed redistribution, for