Shirokov[2] has found a similar representation of the Lorentz group.

In view of (4), the transformation (3) can be written in the form

$$u(p) \to u(p); \qquad a(p) \to Z_L(p)\, a(L^{-1}p).$$

Carrying through similar considerations for the amplitudes b (making use of the charge conjugation of the u and v), we arrive at the following result: the transformation (2) reduces to the following system of transformations for the field amplitudes:

$$a(p) \to Z_L(p)\, a(L^{-1}p); \qquad b(p) \to Z_L(p)\, d(L^{-1}p). \quad (6)$$

Under this transformation the quantities $u(p)$ and $v(p)$ are not transformed at all. The transformation for the conjugate amplitudes a^+ and b^+ follow uniquely from (6).

The transformaion (6) can be represented in operator form. Let A be an operator in the space of the amplitudes $a_\alpha(p)$, $b_\alpha(p)$. The symbol $\langle A \rangle$ shall denote the expression

$$\langle A \rangle = \sum_{\alpha,\beta=1}^{4} \int a_\alpha^+(p)\,(p\alpha \mid A \mid q\beta)\, a_\beta(q)\, d\Gamma_p d\Gamma_q$$

(in order to condense the notation we have put $a_3 = b_4$, $a_4 = b_3$).

We arrive at the following relations:

$$e^{-\langle A \rangle} a_\alpha(p)\, e^{\langle A \rangle} = \sum_{\beta=1}^{4} \int (p\alpha \mid e^{A} \mid q\beta)\, a_\beta(q)\, d\Gamma_q; \quad (7)$$

$$e^{-\langle A \rangle} a_\alpha^+(p)\, e^{\langle A \rangle} = \sum_{\beta=1}^{4} \int a_\beta^+(q)\,(q\beta \mid e^{-A} \mid p\alpha)\, d\Gamma_q.$$

If, for A we take the operator $(\frac{1}{2})\, i\epsilon_{\mu\nu} M_{\mu\nu}$, where $M_{\mu\nu}$ is the four-dimensional angular momentum for the representation (5), then (7) will describe the proper Lorentz transformations (6). Space reflections can be handled in a similar way.

The transformation corresponding to a translation can be put in the form of Eq. (7), setting

$$\langle A \rangle = i\alpha_\mu P_\mu = i\alpha_\mu \int p_\mu \{a^+(p)\, a(p) + b^+(p)\, b(p)\}\, d\Gamma.$$

In addition to the Lorentz transformation many other transformations can be represented in the form of Eq. (7); examples are charge conjugation, gauge transformations, etc. For instance, for a gauge transformation (with a constant phase α) we must take

$$\langle A \rangle = i\alpha Q = i\alpha \int \{a^+(p)\, a(p) - b^+(p)\, b(p)\}\, d\Gamma.$$

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Determination of the Spins of K-Particles and Hyperons

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At present very little is known about the spin values of heavy mesons and hyperons. Some information can be obtained from a detailed study of the decay products[1-3]. But even for the τ-particles, which occupy the most privileged position among all the "strange" particles, there are inconsistent data[4,5].

As "strange" particles cannot be transformed into "common" particles as the result of a strong interaction, they are not produced with large probability in reactions analogous to the reaction $p + p \rightleftarrows d + \pi$, by means of which it would be possible to determine the spin of one unknown particle. The reaction

$$K^- + d \rightleftarrows \Sigma^- + p, \quad (1)$$

which is analogous to the reaction $\pi^- + d \leftrightarrows n + n$, is not forbidden for slow scalar K-particles, as is was for π-mesons, inasmuch as Σ^- and p do not appear to be identical particles. Lee[6] has shown that the reaction (1) can be used for determining the spins of the new particles.

It is not difficult to see that for the same purposes the analogous reactions with various other nuclei can be used together with (1), for example,

$$K^- + H^3 \rightleftarrows \Sigma^- + d, \quad K^- + He_2^4 \rightleftarrows \Sigma^- + He_2^3, \quad (2)$$

$$K^- + He_2^4 \rightleftarrows \Lambda^0 + H^3, \text{ etc.} \quad (3)$$

The experimental data on the interaction of slow K-particles with nuclei seem to indicate that the first of the two capture processes

$$K^- + N \rightarrow \Lambda^0 + \pi, \quad K^- + N \rightarrow \Sigma + \pi \qquad (4)$$

is more probable than the second[4] by an order of magnitude. In connection with these, on the one hand, a study of the reaction of type (3) may be fruitful; but, on the other hand, it is of interest to examine other possibilities for obtaining information about the spins of the new particles. Some information can be obtained from a comparison of the probabilities of exchange collisions of K-particles with hydrogen and deuterons[8].

Another possibility of obtaining information about the spins of hyperons and K-particles is connected with the fact that beams of particles produced in nuclear interactions are partly polarized. As is well known, the scattering cross section of a polarized beam depends on the angle θ as well as on the azimuth φ. But if the θ dependence is connected with which transitions play a role, then the nature of the φ dependence is determined by the spin of the particle. Thus for particles with spin ½ the characteristic dependence is proportional to $\cos\varphi$, for spin 1, to $\cos\varphi + A \cos 2\varphi$, and for spin 3/2, to $\cos\varphi + a \cos 2\varphi + b \cos 3\varphi$. For particles with arbitrary spin the φ dependence is characterized by the expression

$$\sum_{n=1}^{2s} A_n \cos n\varphi,$$

where s is the spin of the particle. The origin of such a dependence is connected with the fact that the orbital angular momentum does not have a z-component ($m = 0$), so that the values of the z-component of the total angular momentum agree with the allowed values of the z-components of the spin of the particles.

Knowing, e.g., the mode of decay, it is possible to ascertain whether the particles are bosons (integral spin) or fermions (half-integral spin). Consequently, knowing, e.g., that the K-particle appears to be a boson, it is necessary to have the possibility to separate experimentally the absence of a dependence on φ for $s = 0$ from the existence of the dependence of the form $\cos\varphi + A \cos 2\varphi$ for $s = 1$.

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Spin-Orbit Interaction in Nuclear Magnetic Multipole Radiation

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In Moszkowski's review[1] of nuclear multipole radiation, esitmates are given for the probabilities of radiative transitions in the single-particle nuclear model. For ML-radiation with a nucleonic transition from the state (n_1, l_1, j_1, μ_1) to the state (n_2, l_2, j_2, μ_2) with the following changes of the nucleonic moments: $\Delta j = L$; $\Delta l = L + 1$ (for example, $M1$-radiation from the $d_{3/2} - s_{1/2}$ transition), the formulas which are given are unsuitable. As has been noted in Ref. 2, in proton transitions of this type, the proton spin-orbit interaction makes an essential contribution, so that the perturbation operator contains the additional term $-(e/c)\Phi \times (v)\, (\sigma \cdot \mathbf{r} \times \mathbf{A})$. In a neutron transition this term does not appear because the neutron bears no charge. However, even in this case an ML-transition is not absolutely forbidden, as is assumed in Refs. 1 and 2. Its intensity is lower [by the factor $\sim (4E^2/1840 \cdot (2L + 3))$] than the intensity of the corresponding proton transition (E is the photon energy in mev), but it is comparable with the probability of the electric multipole transition $E(L + 1)$ for energies of the order of 5 mev with $A = 100$, and for energies < 1 mev in the case of transition with $L > 1$.