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UNITARY SYMMETRY AND THE POINCARÉ GROUP

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The question of combining the Poincaré group P with the group of internal symmetries S (simple Lie group) is now under discussion in many papers [1-5]. It is necessary to clarify first whether this unification is not trivial. The most convincing result in this direction was obtained by Michel [3]. However, even this result was obtained under rather stringent limitations on the group G , which is the combination of the groups P and S (it is assumed that each element $g \in G$ is of the form $g = sp$, $s \in S$, $p \in P$). However, as can be seen from [4,5] and other papers, the union of the two groups $G \supset PS$ contains elements which cannot be represented in the form sp . The Lie algebra of such a group always contains generators which belong neither to the algebra P nor S . It is therefore natural to clarify in this case the question of the triviality or nontriviality of the given union.

In the present note we obtain the conditions under which an algebra, containing in addition to the generators of the algebras P and S also additional generators, is a trivial union of P and S.

Let the generators of the algebra G be the generators of the algebras P and S, and also the generators of H'_l and E'_γ , satisfying the conditions

$$[H'_l, H'_m] = 0 \quad (l, m = 1, 2, \dots, k), \quad (1)$$

$$[E'_\gamma, E'_\nu] \neq 0 \quad (\gamma, \nu = 1, 2, \dots, r) \quad (2)$$

In addition we assume that for an arbitrary γ we can indicate an l such that

$$[E'_\gamma, H'_m] = 0 \quad \text{for } m \neq l, \quad [E'_\gamma, H'_l] \neq 0 \quad (3)$$

The generators of the algebras P and S satisfy the conditions

$$[P_\rho, P_\sigma] = \lambda_{\rho\sigma}^\tau P_\tau \quad (\tau, \rho, \sigma = 1, 2, \dots, 10) \quad (4)$$

$$[H_i, H_j] = 0 \quad (i, j = 1, 2, \dots, n)$$

$$[H_i, E_\alpha] = r_i(\alpha) E_\alpha$$

$$[E_\alpha, E_{-\alpha}]_- = \sum_i r_i(\alpha) H_i \quad \text{or} \quad \sum_{\text{over simple roots}} [E_\alpha, E_{-\alpha}] r_i(\alpha) = H_i \quad (5)$$

$$[E_\alpha, E_\beta] = N_{\alpha\beta} E_{\alpha+\beta} \quad (\alpha \neq -\beta)$$

$$[H_i, P_\rho] = 0 \quad (6)$$

We shall prove that $[E_\alpha, P_\rho] = 0$, i.e., the union of G will be physically trivial and no mass formula can be obtained in any one of the following three cases:

$$1. \quad [H_j, H'_l] = A_{jl}^m H'_m, \quad [P_\rho, E'_\gamma]_- = B_{\rho\gamma}^\nu E'_\nu, \quad [E'_\gamma, E_\alpha]_- = 0 \quad (7)$$

Proof. Under the assumptions made regarding the group G

$$[E_\alpha, P_\rho] = a_{\alpha\rho}^\beta E_\beta + b_{\alpha\rho}^j H_j + c_{\alpha\rho}^\tau P_\tau + d_{\alpha\rho}^l H'_l + f_{\alpha\rho}^\gamma E'_\gamma \quad (8)$$

Inasmuch as G, by definition, is a Lie group, the following Jacobi identity holds true

$$\begin{aligned} J(E_\alpha, P_\rho, H_i) &\equiv [[E_\alpha, P_\rho], H_i] + [[P_\rho, H_i], E_\alpha] + [[H_i, E_\alpha], P_\rho] \\ &= a_{\alpha\rho}^\beta (r_i(\alpha) - r_i(\beta)) E_\beta + d_{\alpha\rho}^l [H'_l, H_i] + f_{\alpha\rho}^\gamma [E'_\gamma, H_i] \\ &+ r_i(\alpha) (b_{\alpha\rho}^j H_j + c_{\alpha\rho}^\tau P_\tau + d_{\alpha\rho}^l H'_l + f_{\alpha\rho}^\gamma E'_\gamma) = 0 \end{aligned} \quad (9)$$

From (9), taking into account the conditions (5) and (7), it follows that

$$a_{\alpha\rho}^\beta = \delta_\alpha^\beta a_{\alpha\rho}, \quad b_{\alpha\rho}^j = 0, \quad c_{\alpha\rho}^\tau = 0, \quad f_{\alpha\rho}^\gamma = 0 \quad (10)$$

We consider further the following Jacobi identity

$$J(E_\alpha, P_\rho, E'_\gamma) = a_{\alpha\rho}^\beta [E_\beta, E'_\gamma] + b_{\alpha\rho}^j [H_j, E'_\gamma] + c_{\alpha\rho}^\tau [P_\tau, E'_\gamma] \\ + d_{\alpha\rho}^l [H_l, E'_\gamma] + f_{\alpha\rho}^\nu [E'_\nu, E'_\gamma] = 0 \quad (11)$$

Taking (3) and (10) into account, it follows from (11) that

$$d_{\alpha\rho}^l = 0 \quad (12)$$

To prove that $a_{\alpha\rho} = 0$, it is sufficient to use the Jacobi identity

$$J(P_\rho, P_\sigma, E_\alpha) \equiv 0 \quad (13)$$

and the properties of the constants $\lambda_{\rho\sigma}^\tau$ (see [1]).

$$2. \quad [E'_\gamma, H_i] = D_{\gamma i}^\nu E'_\nu, \quad [P_\rho, H_l]_- = C_{\rho l}^m H_m, \quad [H_l, E_\alpha] = 0 \quad (14)$$

3. If there exists in G at least one generator of H_l which commutes with the generators of P and S , then in this case, too, $[E_\alpha, P_\rho] = 0$.

To prove these statements it is necessary to use in lieu of (11) the identity

$$J(E_\alpha, P_\rho, H_l) \equiv 0 \quad (15)$$

In conclusion we note that if condition (6) is not satisfied for all i , then, as shown in [2], we can construct a nontrivial union G , the generators of which will be only P_ρ , H_i , and E_α .

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POSSIBLE SUPERCONDUCTIVITY MECHANISM IN CRYSTALLINE FILMS

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New superconductivity mechanisms have been proposed in many recent papers [1,2]. We consider below one possibility of establishment of a superconducting state, due to the presence of different groups of electrons in a crystalline film. The interaction between the electrons of these groups leads, if certain conditions are satisfied (see below), to Cooper pairing. For a bulky crystal, the non-phonon superconductivity mechanism, due to interband interaction, was considered by Geilikman [2], who established a general criterion, which is