Coherence Effects
in the Lee-Yang Parity Doublet Theory of Strange Particles.

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Summary. — It is shown that certain coherence effects occur in the parity doublet theory of strange particles which may give rise to peculiar time and angular dependences in angular correlations. The possibility of observing such effects is closely related to the values of the mass differences in the parity doublets, and it would in fact permit measurement of the mass differences. A condition for the observability of the coherence effects is that the electromagnetic interaction be minimal. Other physical aspects of the theory, such as the time dependence of the decay rates, the lifetimes of hyperons, and the parity doublet structure of hyperfragments, are discussed.

Introduction.

In this paper we show that certain coherence effects occur in the parity doublet theory (*) of strange particles which give rise to peculiar phenomena, such as time dependent angular correlations with a damped oscillating part consisting of terms of odd parity (*). The frequency of the oscillations will in general be of the order of the mass difference in a parity doublet (we use units \( h = 1, c = 1 \)). If such mass difference is large compared to the inverse decay lifetime the very rapid oscillations would not be observable. If the mass difference


(*) Note added in proof. - A parallel investigation has been carried out by G. Morpurgo (Nuovo Cimento: to be published). Similar results have been obtained by T. D. Lee and C. N. Yang (Phys. Rev.: to be published).
is comparable to the inverse decay lifetime the effects could be observed and provide a very accurate measurement of the mass difference itself. The problem of the mass differences in a parity doublet is related to the question of the minimal electromagnetic interaction. If the electromagnetic interaction is minimal only the weak interactions can originate a mass difference between the two members of a parity doublet. In this case the mass differences may be expected to be of the order of the inverse decay lifetimes, and the coherence effects discussed here could result observable. Effects due to the superposition of amplitudes corresponding to the two components of a parity doublet will be most apparent if the two components have nearly equal lifetimes. This possibility is however not implied by the Lee-Yang theory.

We show that, except for cascade decays, no odd parity terms are expected to occur in the case of parity nonconservation in weak interactions. The detection of such terms would be a stringent argument in favor of the parity doublet theory. Other physical consequences of the parity doublet theory, such as the time dependence of the decay rates, the question of the relative frequencies of the various kinds of events in associated production and their relation to the hyperon lifetimes, and the parity doublet structure of hyperfragments are discussed.

1. – The Lee-Yang Parity Doublet Theory.

It has been shown by Dalitz (2) from an analysis of the data on $K_{3\pi}^+$ decays that the particle responsible for these events cannot decay according to the $K_{3\pi}^+$ mode — if angular momentum and parity are conserved in the transition. It must be stressed that this result entirely rests on the present rather limited statistics and also on a number of theoretical assumptions which could be not valid if the $\tau$ had a very complicated structure. (One could argue, for instance, that to reconcile with a unique $K^+$-meson the observed ratio between the $K_{3\pi}^+$ and the $K_{2\pi}^+$ frequencies, a comparison of the two available phase spaces leads to postulate an interaction radius for the decay much larger than the $K$-meson Compton wavelength.) Experimentally all $K$-mesons exhibit same mass, same lifetime, and same cross-sections in strong interactions. Assuming the existence of two different $K$-mesons, $\tau$ and $0$, with same spin but opposite parity, Lee and Yang (1) consider the assumption that the approximate equality of masses follows from some invariance property. This assumption leads to postulate that the strong hamiltonian (that part of the total hamiltonian which conserves total isotopic spin) commutes with a parity