Scalar Densities and Mesons (*) (**).

Y. Y. LEE (***)

The Enrico Fermi Institute and the Department of Physics
The University of Chicago - Chicago, Ill.

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Summary. — It is assumed that the strong-interaction Hamiltonian is broken from the chiral $SU_3 \times SU_3$ symmetry by scalar densities $(u_0 + cu_8)$, where $c$ is a parameter and $u_0, u_8$ transforms like components of the $(3, \bar{3}) + (\bar{3}, 3)$ representation of the chiral $SU_3 \times SU_3$ group. An assumption of asymptotic symmetry on this scalar and pseudoscalar densities is also made. Calculations are made to correlate the pseudoscalar mesons as well as the much proposed kappa-meson. The $\gamma$-X mixing problem is also tried.

1. — Introduction.

It has long been suggested (*) that the strong interaction satisfies an approximate chiral $SU_3 \times SU_3$ symmetry. This assumption has been brought back again recently in a number of applications (**) and (***) . In all these papers, it has been assumed that the chiral $SU_3 \times SU_3$ symmetry is broken in such a fashion:

\[
H = H_0 + H_1,
\]

\[
H_1 = u_0 - cu_8,
\]

with electromagnetic interaction neglected, where $H_0$ is an invariant of the

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(***) On leave of absence from Institute of Physics, National Tsing Hua University, Hsin Chu, Taiwan, Republic of China.


chiral $SU_3 \times SU_3$ group, and $u$, transforms like a component in the $(3, \bar{3}) + (\bar{3}, 3)$ representation of the said group. $c$ is a constant which has been found to be quite close to $-\sqrt{2}$, so that the symmetry after breaking is quite close to chiral $SU_2 \times SU_2$. It was also indicated in a recent work that this symmetry breaking may be caused by spontaneous breakdown (4).

In the paper of Gell-Mann et al. (5) an assumption has been made that the matrix elements $\langle \phi_1^\dagger(p)|u\rangle\phi_2(p')$, with $|\phi_2(p)\rangle$ denoting the pseudoscalar-meson states, satisfy the Wigner-Eckart theorem (their eq. (3.6)). When the symmetry is broken, this can be true only to the first order. As a result, all the $f$ factors in the paper were found to be equal, which is contrary to the experimental fact. Also, it is hard to use their rough model to solve the problem of possible mixing effect of the $\tau$-meson and the $X_0$-meson.

In this paper, we offer as an alternative assumption that the symmetry will be exact in the asymptotic limit. We will state what that means in the following Section. Using this assumption, as well as the assumed transformation properties of the scalar and pseudoscalar densities, we correlated some of the properties of the pseudoscalar mesons, as well as the much proposed kappa-meson (6) (that was proposed to be responsible for the partial conservation of the strangeness-changing vector currents). We also try to solve the $\tau$-$X$ mixing problem (7).

2. - Assumptions and calculations.

Let us first state the main assumptions we made:

1) The symmetry of the strongly interacting system approximately satisfies the chiral $SU_3 \times SU_3$ symmetry; i.e. we write the Hamiltonian as

\begin{equation}
H = H_0 - u_0 - cu_s,
\end{equation}


\footnote{(5) The PCAC factors $f$ in the paper of Gell-Mann et al. are related to the corresponding factors $F$ by the relation $2f = 1/F$.}


\footnote{(7) The $\tau$-$X$ mixing problem has also been worked by other people, using a single angle to relate a pure $|S_0\rangle$ and a pure $|I_0\rangle$ state; see e.g. L. Schülke: Weizmann Institute preprint. However, we assume in this paper that the mixing occurs between the current divergences, which is different from their approach.}