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ON THE COUPLING BETWEEN (Λ^{o},p) FIELD AND THE K-MESON FIELD

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ON THE COUPLING BETWEEN (Λ^o,p) FIELD AND THE K-MESON FIELD*§

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It can be shown[1] that if the decay $\Lambda^o \to p + \mu + \nu$ goes through a Fermi coupling with constant of the order of that of β-decay ($= 3 \cdot 10^{-49}$ erg cm^3) then the mean life of the process will be about 200 times longer than the experimental one. That is, for about 200 decays of Λ^o into p + π there will be only one going to p + μ + ν.

We now ask whether the decay into 3 fermions can proceed through the interaction with the K-meson field, that is $\Lambda^o \to p + K \to p + \mu + \nu$, the intermediate state being a virtual one. The calculations we have done lead to the following result. If both couplings (Λ^o, p; K) and (μ, ν ; K) are scalar, the expression for the mean life is

$$1/\tau = 2 \cdot 10^{104} (4\pi \hbar c)^2 K^{-4} \cdot (G^2/4\pi \hbar c) (g^2/4\pi \hbar c), \qquad (1)$$

where all quantities are in c.g.s. units, K is the inverse compton

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wave length of the K-meson, G is the coupling constant in the vertex (Λ^o,p; K) and g is the coupling constant in the vertex (μ, ν; K). Using for g the value as given by the rate of the $K \to \mu + \nu$ decay ($g^2/4\pi\hbar c = 2.3\cdot10^{-16}$) we get

$$\tau(G^2/4\pi\hbar c) = 5.3\cdot10^{-5}. \qquad (2)$$

This means that even if the decay into three fermions occurs in only one thousandth of the cases ($\tau = 1000\tau_{exp}$, with $\tau_{exp} = 2.85\cdot10^{-10}$s) the coupling constant has the quite unreasonably large value of $G^2/4\pi\hbar c = 1.8\cdot10^2$.

The calculations have shown that if any other coupling except the scalar one is assumed at any of the two vertices, then the value of $G^2/4\pi\hbar c$ will be larger than that given by (1) or (2).

The implication of these results is that if $G^2/4\pi\hbar c$ has a value about 1, as estimated by Gell-Mann[2] and by Matthews and Salam[3] then the decay $\Lambda^o \to p + \mu + \nu$ through this mechanism will occur in only one out of $1.8\cdot10^5$ cases. The direct Fermi interaction of the type considered by L. Lopes[1] would then be the dominant interaction leading to the three fermions.

For a given value of $G^2/4\pi\hbar c$ the small rate of the decay is in part due to the large value of the K-meson mass in (1) and in part due to the small value of $g^2/4\pi\hbar c$. This last factor can be modified by considering that it is possible that in virtue of some selection rule the decay rate of $K \to \mu + \nu$ is smaller by a factor of the order of 10^2 than the value expected simply from the magnitude of the coupling constants. This consideration would increase the value of $g^2/4\pi\hbar c$ by a factor of 10^2, the right hand side of (2) becomming $5.3\cdot10^{-3}$.

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1. L. Lopes: An. Acad. Bras. de Ciencias (in press).

2. M. Gell-Mann: Phys. Rev., **106**, 1296 (1957).

3. P. T. Matthews and A. Salam: Phys. Rev. (in press).