NOTAS DE FISICA

VOLUME V

Nº 4

THE ATTRACTIVE K^--MESON PROTON INTERACTION

By

ERASMO M. FERREIRA

CENTRO BRASILEIRO DE PESQUISAS FISICAS

Av. Wenceslau Braz, 71

RIO DE JANEIRO

1959

Notas de Física - Volume V - Nº 4

THE ATTRACTIVE K^--MESON PROTON INTERACTION*§

By

Erasmo M. Ferreira+

Department of Mathematics, Imperial College, London

Experiments[1,2] seem to indicate the K^--Proton interaction to be attractive. However it is known that the lowest (2nd) order perturbation theory matrix element $K^- p \longrightarrow Y \longrightarrow K^- p$, where Y represent Λ or Σ (virtual) hyperons, has a sign that corresponds to a repulsive potential between K^- and proton for either parity of Λ and Σ hyperons. The question then arises wheter or not the higher order matrix elements give contributions of the correct sign and large enough to make agreement with experiment possible.

We have calculated one of these higher order diagrams, that obtained from the lowest order one by adding the exchange of a π-meson between the incident and the outgoing proton. We specialized to the case of forward and threshold (zero kinetic energy) scattering. The ratios $M^{(4)}/M^{(2)}$ of this fourth order matrix element to the second order one for the several possible parities of the Λ and Σ hyperons are indicated in the table below.

We note that the ratio is always negative for any parities

* Supported by the National Research Council of Brasil.

+ On leave of absence from the Centro Brasileiro de Pesquisas Físicas, Rio de Janeiro, Brasil.

§ Submitted for publication in Nuovo Cimento.

$\Gamma_{K\Lambda N}$	$\Gamma_{K\Sigma N}$	$M^{(4)} / M^{(2)}$
1	1	$-\frac{G_\pi^2}{4\pi\hbar c}\ 0.06\ \frac{G_{K\Lambda N}^2 + 5\ G_{K\Sigma N}^2}{G_{K\Lambda N}^2 + G_{K\Sigma N}^2}$
1	γ_5	$-\frac{G_\pi^2}{4\pi\hbar c}\ 0.06\ \frac{G_{K\Lambda N}^2 + 4.24\ G_{K\Sigma N}^2}{G_{K\Lambda N}^2 + 0.125\ G_{K\Sigma N}^2}$
γ_5	1	$-\frac{G_\pi^2}{4\pi\hbar c}\ 0.41\ \frac{G_{K\Lambda N}^2 + 5.9\ G_{K\Sigma N}^2}{G_{K\Lambda N}^2 + 8\ G_{K\Sigma N}^2}$
γ_5	γ_5	$-\frac{G_\pi^2}{4\pi\hbar c}\ 0.41\ \frac{G_{K\Lambda N}^2 + 5\ G_{K\Sigma N}^2}{G_{K\Lambda N}^2 + G_{K\Sigma N}^2}$

and values of the coupling constants and that for $G_\pi^2 / 4\pi\hbar c = 15$ its extreme values are -0.9 (for G = 0, $\Gamma_{K\Lambda N} = 1$) and -30 (for $G_{K\Lambda N} = 0$, $\Gamma_{K\Sigma N} = \gamma_5$).

The matrix element for the graph considered presents thus the desired features, having the convenient sign and being large enough to compensate the second order term.

The K^--Proton system is a mixture of T = 1 and T= 0 isotopic spin states. It is interesting to note that if we assume that only one of these states contribute to the interaction, the potential derived from our graph is still attractive for all possible parities and values of coupling constants. That is, no minus sign arises in the splitting into iso-spin states. For example, in the case of equal parities attributed to the Λ and Σ hyperons, the T = 1 state will give a matrix element proportional to $G^2_{K\Lambda N} + 2G^2_{K\Sigma N}$, and the T = 0 one will be proportional to $3G^2_{K\Sigma N}$. This equality of signs of the T = 1 and T = 0 interactions is in agreement with the result of the phenomenological analysis presented by R. H. Dalitz (see reference (2), p. 189).

We are greatly indebted to Professor A. Salam and Dr. P. T. Matthews for guidance and encouragement.

1. W. Alles, N. N. Biswas, M. Ceccarelli, J. Crussard - Nuovo Cimento **6**, 571 (1957).

2. R. H. Dalitz, Proceedings of the 1958 Geneva Conference, p. 187.