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PHOTOPRODUCTION OF STRANGE PARTICLES

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Photoproduction of $\Lambda^0 K^+$ near the threshold is considered in the K* "particle" exchange approximation. The result is compared with experiment. Agreement is observed for a relative parity $P_{\Lambda p} = -1$ in the ΛK*p vertex.

THE experiments made by the Alvarez group[1] point to the existence of a narrow K* resonance in the Kπ system at 878 MeV. With respect to the unstable "particle" K* we know at present that its space spin is S = 1 (vector or pseudovector) and its isotopic spin is I = ½. Recently the reaction $\pi^- + p \rightarrow \Lambda^0 + K^0$ was considered by several authors[2-4] in the pole approximation with account of only the exchange of the K* "particle." A theoretical analysis of this reaction enables us to draw certain conclusions concerning the spin of the K* "particle" and obtain an estimate for the ΛK*p interaction constant. However, a study of this reaction does not lead to definite conclusions regarding the relative parity ($P_{\Lambda p}$), in the ΛK*p vertex, since both possible parity variants $P_{\Lambda p} = \pm 1$ yield equally satisfactory agreement with experiment.

In the present note we consider the simultaneous ΛK production in the reaction

$$\gamma + p \rightarrow \Lambda^0 + K^+ \tag{1}$$

in the approximation of the K* "particle" exchange (Fig. 1). The result obtained is compared with experiments on photoproduction of strange particles near threshold. It is shown that satisfactory agreement with experiment exists only when $P_{\Lambda p} = -1$. The estimate for the γK*K interaction constant is found to be crude.

For simplicity we do not take into account the isotopic relations, since the largest quantity of experimental data is available only for reaction (1), and we assume everywhere that K* is a spatial vector and not a pseudovector, which seems to be more likely. We likewise disregard the radiative corrections to the Green's functions with vertex operators (see [4]).

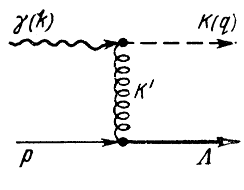

FIG. 1

The angular distribution of K^+ in the c.m.s. is determined in this approximation by the expression

$$\frac{d\sigma(\theta)}{d\Omega} = \frac{(\Lambda_1\Lambda_2)^2}{32\pi^2}\frac{kq^3}{(t+m^2)^2}$$

$$+ \left\{\sin^2\theta + \frac{1}{2W^2}\cos^2\theta\,[t + (M_\Lambda - P_{\Lambda p}M_p)^2]\right\}. \tag{2}$$

Here $t = 2k(\omega - q\cos\theta) - \mu^2$; k is the photon momentum; q, ω, and μ are the momentum, energy, and mass of the K meson; W is the total reaction energy; M_Λ, M_p, and m are the masses of the Λ-hyperon, proton, and K* meson, while Λ_1 and Λ_2 are the constants of the ΛK*p and γK*K interactions, respectively.

A distinguishing feature of this angular distribution is that the term in the square brackets changes strongly near threshold depending on the sign of $P_{\Lambda p}$. When $P_{\Lambda p} = 1$ the angular distribution is characterized, by virtue of the smallness of the difference $M_\Lambda - M_p$, essentially by the factor $\sin^2\theta$ and has a patently anisotropic character. When $P_{\Lambda p} = -1$ the expression in the curly brackets is approximately of the order of unity and the distribution is almost isotropic.

The unknown parameter $\Lambda_1\Lambda_2$ contained in the angular distribution was obtained by us from a comparison with experiment at a single point ($\Lambda_1^2\Lambda_2^2/32\pi^2 \approx 0.35 \times 10^{-28}$ cm$^2 \approx e^2/m_\pi^2$). The value of the constant $\Lambda_1\Lambda_2$ was not made particularly precise, since the available experimental data were not very reliable. Knowing the constant Λ_1 (see [2,3]) we can determine Λ_2 (we note that Λ_2 determines the γK*K interaction and is very simply related with the lifetime in decay via the $K^* \rightarrow K + \gamma$ channel). The estimate obtained agrees with the expected value of the K* lifetime.

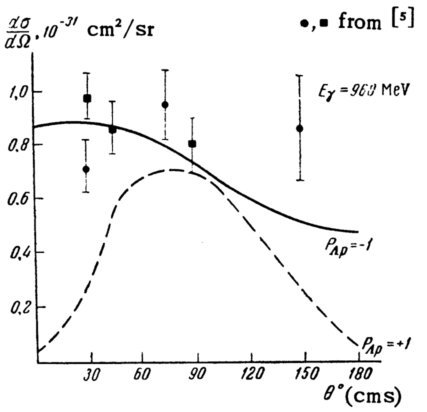

FIG. 2

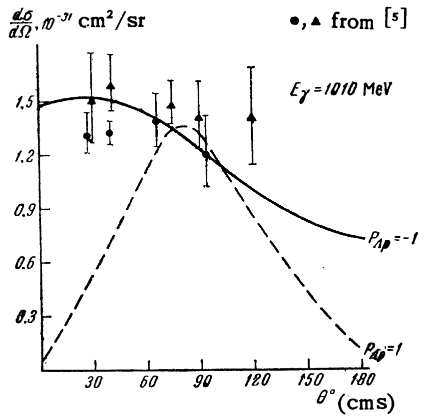

FIG. 4

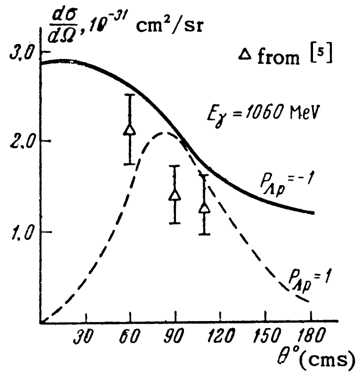

FIG. 3

In Figs. 2, 3, and 4 we have compared the obtained value of angular distribution of reaction (1) with the experimental data on Λ^0K^+ photoproduction near threshold for three values of the energy of the incident quantum (980, 1010, and 1060 MeV). The experimental data were taken from the paper of Turkot[5]. In spite of the appreciable scatter of the experimental points, it is seen from the figures that formula (2) represents well the course of the angular distribution when $P_{\Lambda p} = -1$.

In conclusion, the author expresses his gratitude to K. A. Ter-Martirosyan for interest in the work.

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329