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STUDY OF THE MASS SPECTRUM OF THE ΛK SYSTEM IN $\pi^- p$ INTERACTIONS AT 4 AND 5.1 GeV/c

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We report here the results of the study of the effective-mass spectrum of the ΛK system, obtained in an investigation of $\pi^- p$ interactions in the 24-liter [1] (High-energy Laboratory) and the meter [2] (Nuclear Problems Laboratory) propane bubble chambers irradiated by 4 and 5.1 GeV/c pion beams, respectively, from the JINR proton synchrotron.

The structure of the effective-mass spectrum of the ΛK system is of interest from the point of view of observing new resonances with zero strangeness and the decays of various isobars in the $N^* \to \Lambda + K$ channel for the purpose of determining the relative probabilities of such decays.

The first serious indication of the existence of a resonance structure in the K effective-mass spectrum was obtained in [3], where a resonance of mass $M_{\Lambda K^+} = (1700 \pm 25)$ MeV/c^2 and width $\Gamma = (170 \pm 50)$ MeV/c^2 was observed in the reaction $\pi^- p \to \Lambda K^+ \pi^-$ at 6 GeV/c. This resonance can be attributed to the isobar decay $N^*(1688) \to \Lambda + K^+$. A peak in the effective-mass spectrum of ΛK^0 and ΛK^+, with $M = (1755 \pm 21)$ MeV/c^2 and $\Gamma = (221 \pm 58)$ MeV/c^2, produced in a $\pi^+ p$ interaction at 8 GeV/c, was reported in [4]. The existence of this peak is attributed to the decay of the isobars $N^*_{1/2}(1710)$ and $N^*_{1/2}(1750)$. The mass spectra obtained in [5] for the ΛK system in pp interactions at 8 GeV/c agree with the presence of a resonance with $M = 1777$ MeV/c^2 and width $\Gamma = 345$ MeV/c^2. Finally, in [6] they observed an appreciable excess of events over the background in the ΛK mass spectrum at $M \approx 1680$ MeV/c^2 in the photoproduction reaction $\gamma p \to \Lambda K^0 \pi^+$ (π^0.....), and the existence of this peak cannot be attributed to the decay of an isobar N^* with mass clease to 1680 MeV/c^2, since no isobar $N^*(1680) \to p\pi^-$ was observed in the reaction $\gamma p \to p\pi^-\pi^+$.

The data that follow were obtained by processing approximately 230 000 photographs from the 24-liter chamber and 230 000 photographs from the meter chamber. The photograph processing procedure was described in earlier papers (cf., e.g., [7, 8]).

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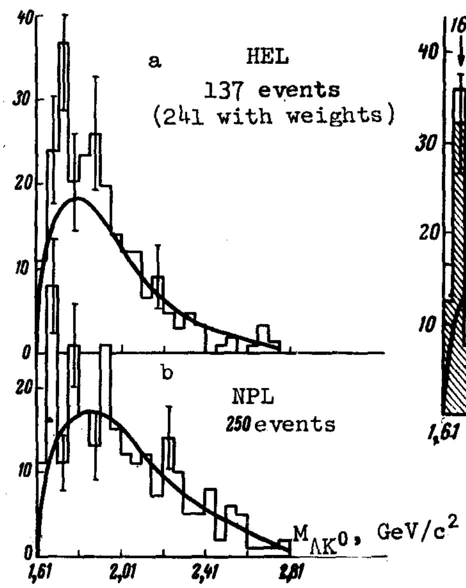
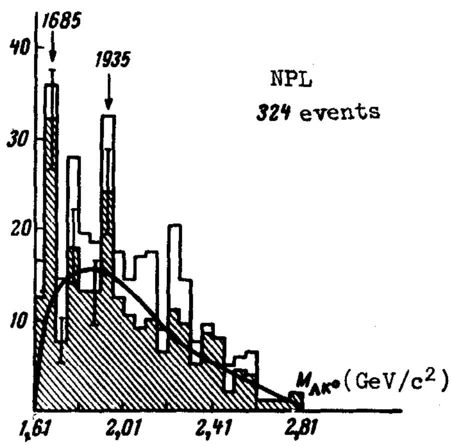
We selected for the analysis events satisfying the $\pi^- p$-interaction criteria, with one or two V^0 particles whose decay was registered in the chamber. A reaction-channel identification program was used to separate the events with the Λ hyperon and with the K^0 (or K^+) meson in the final state.

The effective-mass spectra of the ΛK^0 combinations for events in which Λ hyperons and K^0 mesons were registered simultaneously in the chamber are shown in Figs. 1a and 1b[1)]. The phase curves on both figures take into account the relations between the cross sections of the different reactions, in which the Λ hyperon and the K^0 meson are produced, and are normalized to the spectral region with $M_{\Lambda K} \geq 2$ GeV/c^2.

As seen from the figures, a noticeable excess of the number of events over the background is observed in the mass region (1.61 - 1.96) GeV/c^2. The fact that this anomaly is not connected with the effect of the known resonances Y*(1385) and K*(890) on the ΛK^0 spectrum is demonstrated by Fig. 2. The histogram of Fig. 2 include also events in which only the Λ-hyperon decay was registered in the chamber, and the K^0-meson parameters were determined upon identification of the reaction channel. After eliminating from the histogram the events in





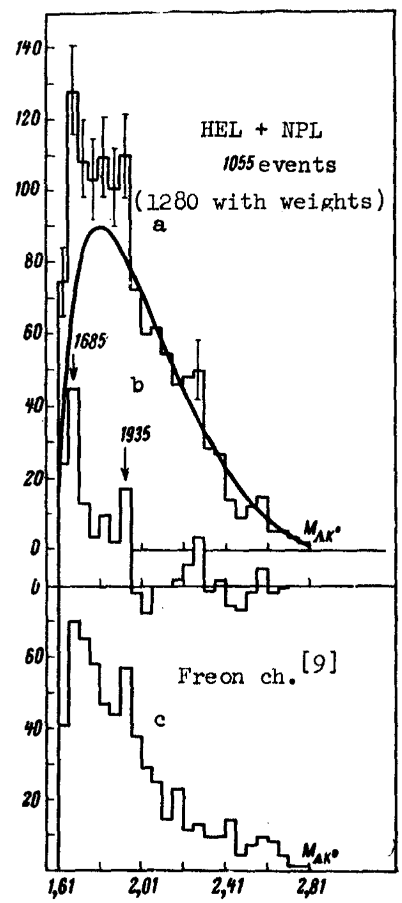


Fig. 1. ΛK^0 effective mass spectra: a - data of High-energy Lab. (HEL), b - data of Nucl. Problems Lab (NPL).

Fig. 2. ΛK^0 effective mass spectra. The shaded histogram represents the $M_{\Lambda K^0}$ spectrum, from which events with $134 \leq M_{\Lambda\pi} \leq 1.42$ Gev/c^2 and $0.83 \leq M_{K\pi} \leq 0.93$ Gev/c^2 have been subtracted.

Fig. 3. a) Summary ΛK effective-mass spectrum; b) ΛK spectrum after subtraction of background curve; c) ΛK^0 spectrum obtained with freon chamber [9].

1) In spectrum 1a, from the data of the 24-liter chamber, account is taken of the weights of the events. In the meter bubble chamber, the weights of the events were close to unity and were not taken into account in the construction of the spectrum 1b.

which the masses $M_{\Lambda\pi}$ and $M_{K\pi}$ lie in the intervals $1.34 \leq M_{\Lambda\pi} \leq 1.42$ GeV/c^2 and $0.83 \leq M_{K\pi} \leq 0.93$ GeV/c^2, the anomaly in the mass region 1.61 - 1.96 GeV/c^2 still remains (shaded spectrum).

The summary effective-mass spectrum of ΛK^0 and ΛK^+, based on the data from both laboratories, is shown in Fig. 3a. The total excess of the number of events over the background, in the mass interval 1.61 - 1.96 GeV/c^2, is 114 ± 13. If this anomaly is due to the existence of only one resonance, then its mass is M = 1736 MeV/c^2 and its approximate width is 300 MeV/c^2. It is seen, however, from Fig. 3b, which shows the spectrum obtained after subtracting the background curve from the histogram, that the experimental data agree with the assumed existence of two resonances with masses near 1685 and 1935 MeV/c^2 and widths on the order of 150 MeV/c^2. A second less reliable peak is also observed in the ΛK^0 spectrum obtained with a freon chamber in a beam of 3.86-GeV/c π^- mesons [9]. The ΛK^0 spectrum obtained with the freon chamber is shown for comparison in Fig. 3c.

An analysis of the angular distributions of the ΛK system, for events with effective masses in the interval (1.61 - 1.76) GeV/c^2, shows that the first peak at M = 1685 MeV/c^2 can hardly be related with the decays of the isobars $N^*_{5/2}(1680)$ and $N^*_{5/2}(1688)$ with spin 5/2.

Thus, the anomaly observed by us in the ΛK effective-mass spectrum can be attributed either to the decay of the isobars $S_{11}(1710)$ and $P_{11}(1750)$ (and, less likely, $D_{13}(1730)$) [10] in the $N^* \to \Lambda + K$ channel, or to the existence of a new resonance with mass near 1685 MeV/c^2, which is indicated also by the data of [6].

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MOSSBAUER EFFECT ON ^{121}Sb NUCLEI IN YTTRIUM IRON GARNET

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We report here the results of an investigation of nuclear gamma resonance in yttrium iron garnet on ^{121}Sb nuclei for the Mossbauer transition with energy 37.2 keV [1]. The investigation revealed a superexchange induction of magnetic fields on the diamagnetic Sb atoms.

The Mossbauer spectra were measured with a setup of the electrodynamic type, operating in the time mode with parabolic motion. The 37.2-keV gamma quanta were registered with a scintillation counter with NaI(Tl) crystal 0.2 mm thick, using the emission peak. The source was radioactive ^{121}Sb in SnO_2.

The figure shows the Mossbauer spectrum of the substituted yttrium iron garnet $Y_{2.5}Ca_{0.5}Sb_{0.25}Fe_{4.75}O_{12}$, obtained at a temperature 100°K. The purely magnetic hyperfine interaction causes splitting of the ground state of ^{121}Sb into 2J(5/2) + 1 = 6 levels and of