Structural feature at 50 GeV/c in the mass spectrum of the $\phi\pi^-$ system in the reaction $\pi^- + \mathrm{Cu} \to \mu^+ + \mu^- + \pi^- + \ldots$

Yu. M. Antipov, V. A. Bezzubov, N. P. Budanov, Yu. P. Gorin, S. P. Denisov, S. V. Klimenko, I. V. Kotov, A. A. Lebedev, A. I. Petrukhin, S. A. Polovnikov, V. N. Roinishvili,[1)] and D. A. Stoyanova
Institute of High-Energy Physics

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The yield of ϕ mesons has been studied as a function of the effective mass of the $\mu^+\mu^-\pi^-$ system in the reaction $\pi^- + \mathrm{Cu} \to \mu^+ + \mu^- + \pi^- + \ldots$ at 50 GeV/c. The results indicate a structural feature in the $\phi\pi^-$ system with a mass $\cong 1.4$ GeV and a width $\lesssim 100$ MeV.

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Bityukov *et al.*[1] have reported observing a structural feature, $C(1430)$, in the effective-mass spectrum of the $\phi\pi^0$ system in the charge exchange of π^- mesons in a LiH target. The mass of this structural feature was found to be 1.43 ± 0.02 GeV, its width 100 ± 30 MeV, and the cross section 10 ± 10 nb. If $C(1430)$ is a bound state of ϕ and π^0 mesons with an isospin of 1, then its charged analog must also exist. In this letter we report a search for a negatively charged analog in the inclusive reaction

$$\begin{array}{l} \pi^- + \mathrm{Cu} \to \mathrm{X}^- + \ldots \\ \qquad\quad \hookrightarrow \phi + \pi^- \\ \qquad\quad\quad \hookrightarrow \mu^+ + \mu^- \end{array} \qquad (1)$$

In a study of the production of J/ψ and ψ' particles in the reaction $\pi^- + \mathrm{Cu} \to \mu^+ + \mu^- + \ldots$, a ϕ-meson signal was observed at 50 GeV/c in the effective-mass spectrum of the $\mu^+\mu^-$ mesons, in experiments using the Sigma apparatus.[2] In addition to muons it was possible to detect charged hadrons and thus to study the $\phi\pi^-$ system.

Figure 1 shows the effective-mass distribution of the $\mu^+\mu^-$ mesons for cases in which the spectrometer detected, in addition to muons, at least one negatively charged particle, which turned out to be a π^- meson. The distributions are shown for various regions of the effective mass of the $\mu^+\mu^-\pi^-$ system: from the region with $M_{\mu^+\mu^-\pi^-} \geqslant 1.25$ GeV to that with $M_{\mu^+\mu^-\pi^-} \geqslant 1.75$ GeV at 100-MeV steps. The number of ϕ mesons in each spectrum, N_ϕ, is determined in the following manner: The spectra are approximated by a polynomial distribution without consideration of the dimuon mass region, $1.00 \leqslant M_{\mu^+\mu^-} \leqslant 1.05$ GeV (two bins), and N_ϕ is calculated as the number of events lying above the polynomial background in this mass region.

Figure 2 shows the differential distribution in the mass of the $\mu^+\mu^-\pi^-$ system of the number of ϕ mesons, found as the difference between the corresponding values of N_ϕ. We see that the distribution has a peak at $M_{\mu^+\mu^-\pi^-} \cong 1.4$ GeV. This peak does not

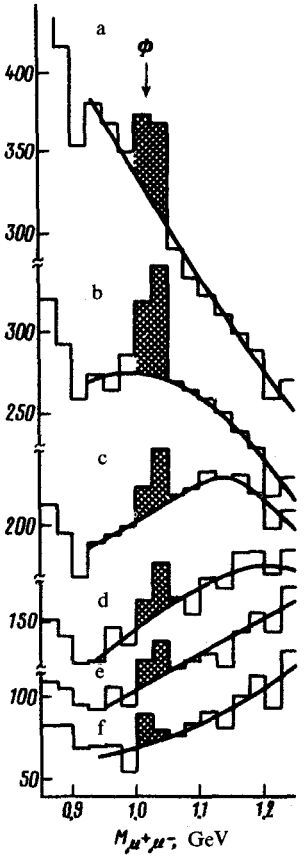

FIG. 1. Distributions of the effective masses of the $\mu^+\mu^-$ mesons in the reaction $\pi^- + \mathrm{Cu} \to \mu^+ + \mu^- + \pi^- + \ldots$. a—The effective mass of the $\mu^+\mu^-\pi^-$ system is $M_{\mu^+\mu^-\pi^-} \geqslant 1.25$ GeV; b—$M_{\mu^+\mu^-\pi^-} \geqslant 1.35$ GeV; c—$M_{\mu^+\mu^-\pi^-} \geqslant 1.45$ GeV; d—$M_{\mu^+\mu^-\pi^-} \geqslant 1.55$ GeV; e—$M_{\mu^+\mu^-\pi^-} \geqslant 1.65$ GeV; f—$M_{\mu^+\mu^-\pi^-} \geqslant 1.75$ GeV.

shrink (Fig. 2b) if we select the events for which the resultant momentum of the $\mu^+\mu^-\pi^-$ system is $P_{\mu^+\mu^-\pi^-} \leqslant 45$ GeV/c. A possible explanation is that pions cannot dissociate into a $\phi\pi$ system.

We were not able to accurately determine the cross section for the production of $\phi\pi^-$ (1.43), but in order of magnitude it is 10 μb per nucleon (we have taken into account the probability for the decay of the ϕ meson into a muon pair).

Consequently, under the assumption that the negative particles detected by the spectrometer but not identified as muons are π^- mesons, our results confirm the results of Ref. 1: There may exist a hadron with a mass $\cong 1.4$ GeV and a width $\lesssim 100$ MeV which decays into ϕ and π mesons. Barinov *et al.*[3] have theoretically predicted

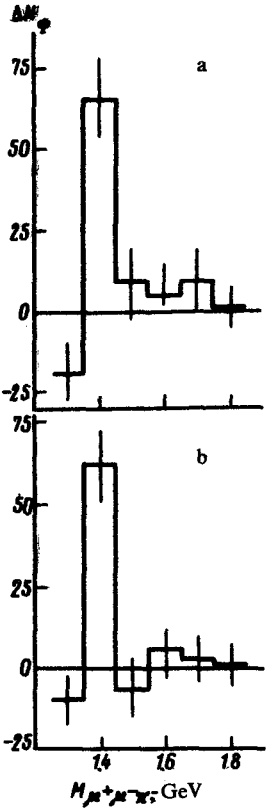

FIG. 2. Differential distributions in the mass of the $\mu^+\mu^-\pi^-$ system of the number of ϕ mesons in the reaction $\pi^- + \mathrm{Cu} \to \mu^+ + \mu^- + \pi^- + \ldots$. a—All events detected by the spectrometer; b—events with $P_{\mu^+\mu^-\pi^-} \leqslant 45$ GeV/c.

the existence of a resonance with approximately these properties.

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[1)]Institute of Physics, Academy of Sciences of the Georgian SSR, Tbilisi.

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