Search for associative production of D^0 mesons with muons in π^-Be interactions at 55 GeV/c

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The wide-aperture "Sigma" spectrometer was used to search for the reaction π^-Be$\to$Be + μ...,$D^0\to K\pi$ at a π^--meson momentum 55 GeV/c. The particles were identified with a multichannel counter, which made it possible to separate pions and kaons in the momentum interval 7–21 GeV/c. No narrow resonances were observed in the effective-mass spectrum of the $K\pi$ systems. Upper-bound estimates were obtained for the D-meson production cross sections.

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To observe the production of "charmed" particles in hadron interactions, we have searched for the reaction

$$\pi^- + \mathrm{Be} \to \underset{\hookrightarrow K\pi}{D^0} + \underset{\hookrightarrow \mu + \ldots}{C} + X, \qquad (1)$$

where D^0 is a "charmed" meson with mass 1863 MeV, and C is a "charmed" particle that decays with emission of a muon. The experiment was performed with the "Sigma" spectrometer (Fig. 1). A beam of negative pions with momentum 55 GeV/c was focused on a 15-cm beryllium target. Behind the target was located a muon filter interlined with scintillation counters and proportional chambers measuring 1.5×0.5

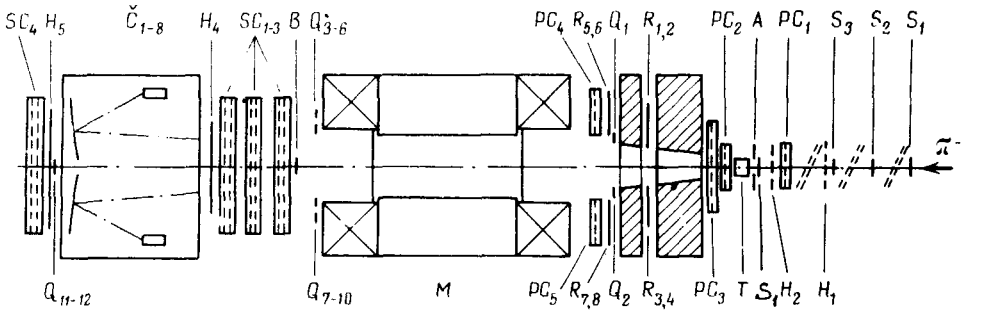

FIG. 1. Experimental setup: S_1–S_4) beam scintillation counters; A, B, 0_1–0_{12}) anticoincidence counters; H_1, H_2, H_4, H_5) scintillation hodoscopes; PC_1–PC_5) proportional chambers; T) beryllium target; R_1–R_8) scintillation counters located behind the steel absorber and used to identify the muons; M) spectrometer magnet; SC_1–SC_4) spark chambers; $\check{C}_{1-8}$) threshold Cerenkov counter.

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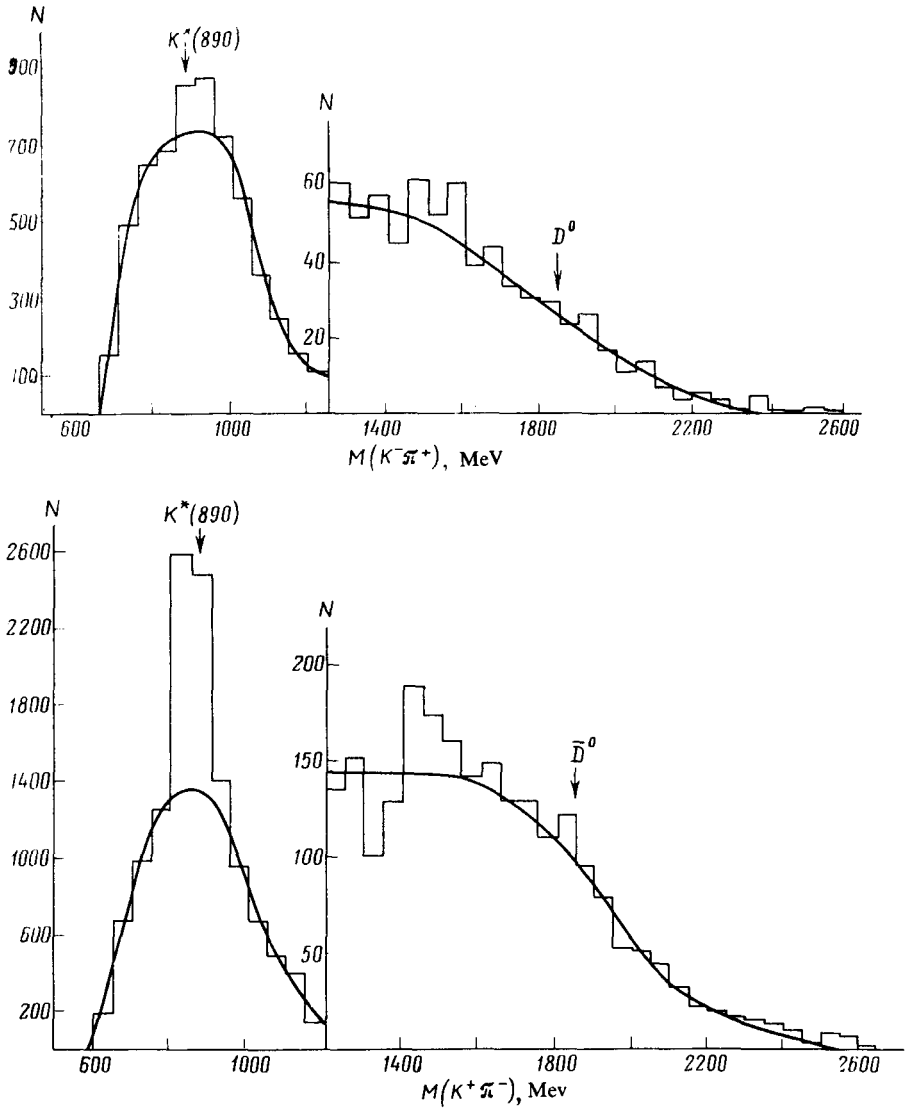

FIG. 2. Effective-mass spectra of the $K\pi$ systems for the reaction $\pi^-\text{Be}\to D^0CX$; $D^0\to K\pi$, $C\to\mu+\ldots$.

m. The total filter thickness was 1.5 m of steel. The filter had an aperture in the center, corresponding to the angular aperture of the spectrometer magnet M. The field in the magnet M was chosen to make the trajectories of the π and K mesons from $D^0\to K\pi$ parallel after passing through the magnet. The particles that passed through the magnet were registered with wire spark chambers SC, oscillation hodoscopes H_4 and H_5, and an eight-channel threshold Cerenkov counter $\check{C}$.[1] The Cerenkov counter was filled with air at atmospheric pressure and made it possible to separate pions and heavier particles in the momentum interval 7–21 GeV/c. To form the trigger it was necessary, first, that at least one charged particle pass through the steel filter, second that at least

one positive and one negative particle pass in different sections of the Cerenkov counter within the limit of their angular acceptance, and third that one of the particles be registered in the Cerenkov counter and the other not be registered.

During the time of the experiment, 4×10^{10} π^- mesons passed through the target, and $\sim10^6$ events were recorded on the magnetic tapes. In the reduction of the data, the particles with momenta in the interval 7–21 GeV/c, registered with the Cerenkov counter, were taken to be pions, while those not registered were taken to be kaons. The spectra of the masses of the $K\pi$ systems, obtained in the experiment, are shown in Fig. 2. It is seen that in the region of the D^0-meson mass there are no statistically significant peaks. From the experimental data it follows that the upper-bound estimate of the cross section for the production of the D^0C pair is 10 μb/nucleon (95% confidence level), if the pair is produced by diffraction. If the D^0C system is produced just as the J/ψ particle,[2] then the corresponding upper bound is 20 μb/nucleon (95% confidence level). The probabilities of the decays $D^0\to K\pi$ and $C\to\mu+\ldots$ were assumed to be 2.2%[3] and 10%, respectively.

We attempted to decrease the nonresonant background in the region of the mass of the W mesons, using the following additional selection criteria for the events:

1) Only one particle in the upper or lower part of the installation is registered behind the steel filter.

2) The kaon momentum exceeds the pion momentum.

3) The value of the variable x of the $K\pi$ system is larger than 0.7.

However, these additional limitations did not make it possible to separate the signal from the D meson or to imporve the upper bounds presented above for the cross sections.

Attempts to register associative production of a charmed particle and a muon in hadron interactions were made also in Refs. 4–6. The cross section bounds obtained in those experiments lie in the region of $\gtrsim 10$ μb. At the present time we see no way of advancing significantly into the region of low cross sections in experiments of this type.

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