Search for paired production of D^0 and $\bar{D}^0$ mesons in π^-Be interactions at 55 GeV/c

Yu. M. Antipov, V. A. Bezzubov, N. P. Budanov, Yu. B. Bushnin, Yu. P. Gorin, S. P. Denisov, F. A. Ech, S. V. Klimenko, V. I. Kotov, A. A. Lebedev, A. A. Lednev, Yu. V. Mikhaĭlov, A. I. Petrukhin, S. A. Polovnikov, V. N. Roĭnishvili,[1)] M. I. Soldatov, and D. A. Stoyanova

Institute of High Energy Physics
(Submitted 31 August 1978)
Pis'ma Zh. Eksp. Teor. Fiz. **28**, No. 7, 495–498 (5 October 1978)

The wide-aperture "Sigma" spectrometer was used to search for paired production of D mesons in the reaction $\pi^-\text{Be}\to D^0\bar{D}^0X$, with $\bar{D}^0\to K^+\pi^\pm$ and $D^0\to K^+\pi^\pm$. To identify the kaons, a multichannel threshold Cerenkov counter was used. In the expected region of the $K\pi$-system masses, not a single event was observed. Upper bounds are estimated for the D-meson production cross section.

PACS numbers: 13.85.Kf, 14.40.Pe

Narrow resonances with mass 1.87 GeV/c^2 were observed in e^+e^- interactions in the $K\pi$ and $K\pi\pi$ systems,[1] and were interpreted as the lowest states of "charmed" D^0 mesons. The large number of experiments notwithstanding, no production of D me-

 0021-3640/78/190457-04$00.60

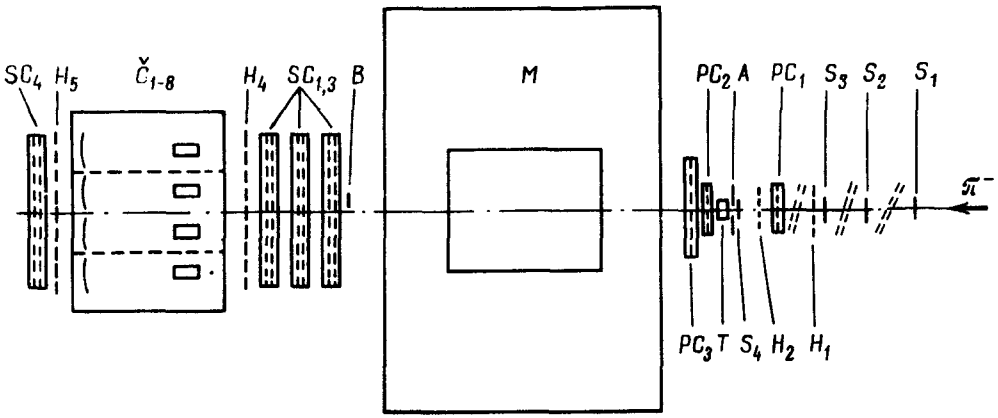

FIG. 1. Experimental setup: S_1–S_4) beam scintillation counters, A, B) anticoincidence counter, H_1, H_2, H_4, H_5) scintillation hodoscopes, PC_1–PC_3) proportional chambers, T) beryllium targer, M) spectrometer magnet, SC_1–SC_4) spark chambers, C_{1-8}) Cerenkov threshold counter.

sons in hadron interactions has been observed to date. The first search for associative production of D^0 mesons in the exclusive process $\pi^- p \to D^0 \bar{D}^0 n$, $D^0 \to K^0 \pi^0$ was made by Apel *et al.*.[2]

We have made an attempt at observing pair production of D^0 mesons in the inclusive reaction

$$\pi^- + \mathrm{Be} \to D^0 + \bar{D}^0 + X, \quad D^0, \bar{D}^0 \to K^{\mp}\pi^{\pm}. \tag{1}$$

The experiment was performed with the "Sigma" spectrometer. The arrangement of the basic apparatus is shown in Fig. 1. A beam of negative particles with momentum 55 GeV/c was focused on a beryllium target 15 cm thick. The field in the spectrometer magnet M was chosen such as to ensure "parallel geometry" for the $D \to K\pi$ decay. The track detectors were proportional and spark wire chambers. The particles were identified with the aid of an eight-channel threshold Cerenkov counter $\check{C}$.[3] Each section of the counter operated as independent detector with an angular acceptance $\pm$ 80 mrad in the horizontal and vertical planes. The Cerenkov counter was filled with air at atmospheric pressure and made it possible to separate pions and heavier particles in the momentum range 7–21 GeV/c. Scintillation hodoscopes H_4 and H_5 (a total of 64 counters) were used to form the trigger. For a trigger signal to appear it was necessary that at least four charged particles pass through the different sections of the Cerenkov counter, two of which were registered by the Cerenkov counter and two were not.

During the time of the experiment, 1.2×10^{11} π^- mesons passed through the installation and 4×10^5 events were recorded on magnetic tapes. In the reduction of the data it was assumed that the event belongs to the reaction

$$\pi^- + \mathrm{Be} \to K^+\pi^- + K^-\pi^+ + X, \tag{2}$$

if it satisfies the following criteria:

1) In the spark chambers are registered at least two positive and two negative

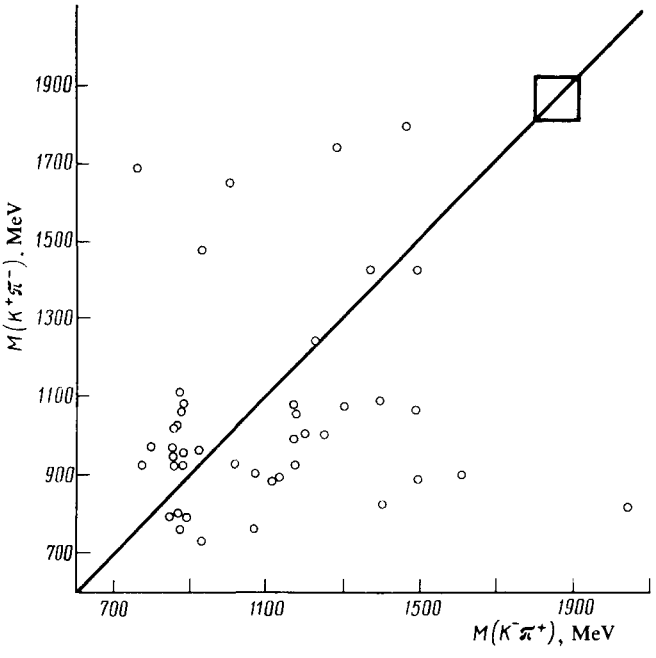

FIG. 2. Two-dimensional distribution of the effective masses of the $K^+\pi^-$ and $K^-\pi^+$ systems. The square marks the mass region corresponding to 95% probability of registration of the reaction (1).

particles, which cause operation of the corresponding cells of the hodoscopes H_4 and H_5.

2) The particle momenta lie in the interval 7–21 GeV, i.e., in the region of effective registration of the pions by the Cerenkov counter, but below the kaon registration threshold.

3) The particle trajectories lie within the limits of the angle acceptance of the Cerenkov counter.

4) At least one positive and one negative particle were registered by the Cerenkov counter (they were hereafter assumed to be pions).

5) At least one negative and one positive particle produce no operation of the sections of the Cerenkov counter through which their trajectories pass (hereafter regarded as kaons).

The foregoing criteria were satisfied by 35 events. The two-dimensional distribution in the $K^+\pi^-$ and $K^-\pi^+$ masses for these events (altogether 44 combinations) is shown in Fig. 2. The expected resolution in the $K\pi$ pair mass is $\pm$ 30 MeV. It is seen from the figure that not a single event that might be interpreted as pair production of D^0 and $\overline{D}^0$ mesons in the reaction (1) was registered in the experiment.

To calculate the geometric effectiveness of the registration of reaction (1), two models were used. In the first it was assumed that the system $D^0\overline{D}^0$ is produced by a

diffraction mechanism. In this case the geometric efficiency of the installation turned out to be 0.26%, and for the upper-bound estimate of the cross section of D-meson production we obtained a value 2 μb/nucleon at a 95% confidence level. The probability of the $D \to K\pi$ decay was assumed equal to 2.2%.[4]

In the second model it was assumed that the distribution of the $D^0\bar{D}^0$ system with respect to x and p_t^2 is the same as for the J/ψ particles.[5] Under this assumption, the geometric efficiency of the installation is 0.06%, the upper limit of the cross section of reaction (1) is 9 μb (90% confidence level).

We note that for reaction (2), at $K\pi$-system masses larger than 1.5 GeV, not a single event was registered in our experiment. Thus, further search for the process (1) is promising.

The authors thank A.A. Longunov, L.D. Solov'ev, and V.A. Yarba for support, and Yu.D. Prokoshkin for useful discussions which prompted the undertaking of the experiment.

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

[1]G. Goldhaber *et al.*, Phys. Rev. Lett. **37**, 255 (1976).
[2]W.D. Apel *et al.*, Lett. Nuovo Cimento **17**, 538 (1976).
[3]Yu.M. Antipov *et al.*, Preprint IHEP-78-4, Serpukhov, 1974.
[4]Yu.M. Antipov, V.A. Bezzubov, N.P. Budanov, Yu.P. Gorin, S.P. Denisov, F.A. Ech, S.V. Klimenko, A.A. Lebedev, Yu.V. Mikhaĭlov, and A.I. Petrukhin, Pis'ma Zh. Eksp. Teor. Fiz. **27**, 312 (1978) [JETP Lett. **27**, 291 (1978)]; Yu.B. Bushnin *et al.*, Phys. Lett. B **72**, 269 (1978).
[5]I. Peruzzi *et al.*, Phys. Rev. Lett. **39**, 1301 (1977).