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Strange-Particle Production at 2.75 GeV/c.

I. – The YKπ Final State.

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Summary. — The strange particle production in π^-+p reactions at 2.75 GeV/c was analysed. The results concerning the three-body final state are presented. The rate of production of the different known resonances is determined by best fit procedures. The $Y_0^*(1405)$ was found at 1375 MeV, as was also found by Miller *et al.* The one-K exchange peripheral model was tested by the Treiman-Yang test, obtaining consistency when $K^*(891)$ production is favored. The total cross-section was found to be $\sigma_T = (1.4 \pm 0.1)$ mb.

1. – Introduction.

Previous experiments ([1-6]) on πp interactions producing strange particles with incident momentum up to a few GeV/c, have shown that in the YKπ

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(1) D. H. MILLER, A. Z. KOVACS, R. MCILWAIN, T. R. PALFREY and G. W. TAUTFEST: *Phys. Rev.*, **140**, B 360 (1965).

(2) G. ALEXANDER, L. JACOBS, G. R. KALBFLEISCH, D. H. MILLER, G. A. SMITH and J. SCHWARZ: *Proceedings of the 1962 International Conference on High-Energy Physics at CERN* (Geneva, 1962), p. 320.

(3) G. ALEXANDER, G. R. KALBFLEISCH, D. H. MILLER and G. A. SMITH: *Phys. Rev. Lett.*, **8**, 447 (1962).

(4) T. P. WANGLER, A. R. ERWIN and W. D. WALKER: *Phys. Rev.*, **137**, 414 (1965).

(5) L. M. HARDY, S. U. CHUNG, O. I. DAHL, R. I. HESS, J. KIRS and D. H. MILLER: UCRL 11442 (1964).

(6) SACLAY-ORSAY-BARI-BOLOGNA COLLABORATION: *Nuovo Cimento*, **42** A, 606 (1966).

final state, the known $K^*(891)$, $Y_1^*(1385)$, $Y_0^*(1405)$ and $Y_0^*(1520)$ resonances are produced in a variable degree, the production angular distribution being consistent with the peripheral model.

This experiment was undertaken to study the rate at which the different resonances are produced, and to increase the knowledge about the peripheral nature of the production mechanism.

The total of 40000 pictures analysed was made with the 80 cm hydrogen bubble chamber of Saclay, exposed at CERN to a beam of (2750 ± 15) MeV/c π^-.

2. – Selection criteria.

All the film was scanned twice with an estimated final efficiency of 99 %.

A total of 504 strange-particle events were found, 115 of which were identified unambiguously as being of one of the different classes of the $YK\pi$ final states.

All the events were processed by a best fit program similar to GUTS. As much as it was possible the ionization of the tracks was determined by measuring the mean gap length on a microscope.

The conditions an event had to fulfil in order to be considered unambiguously classified were:

1) To have a χ^2-value corresponding to a confidence level higher than 10 %.

2) The accepted hypothesis shall have a χ^2-value with a confidence level 3 times as high as that of the following one. This factor was reduced to 2 when the best hypothesis was $\Lambda K\pi$ and the following $\Sigma^0 K\pi$, because it is known that the errors assigned to the Σ^0 events were over-estimated.

3) The results of the mean gap length measurements were consistent with the calibration curves.

3. – Results.

A first estimation of the total cross-section gives a value of (1.4 ± 0.1) mb, consistent with that found by MILLER *et al.* [1] in a similar experiment.

When the isotopic spin allows it, the $YK\pi$ events are dominated by the $K^*(891)$ production, and in that case the characteristics of the different classes of events involved are similar. For that reason we grouped the events in

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3 groups A, B, and C:

$$\left.\begin{array}{lr} (1) & \Sigma^- K^0 \pi^+ , \\ (2) & \Sigma_b K^+ \pi^- , \\ (3) & \Lambda\ K^+ \pi^- , \end{array}\right\} A ,$$

$$\left.\begin{array}{lr} (4) & \Sigma^- K^+ \pi^0 , \\ (5) & \Lambda^0 K^0 \pi^0 , \\ (6) & \Sigma^0 K^0 \pi^0 , \end{array}\right\} B ,$$

$$\begin{array}{lr} (7) & \Sigma^+ K^0 \pi^- , \end{array}\} \ C ,$$

in accordance with the *a priori* probability that the $K\pi$ system was in a $I=\frac{1}{2}$ state which is either dominant, nondominant or zero, respectively. The results confirmed the convenience of that grouping.

In Fig. 1, *a*) the Dalitz plot for the events of the first group is shown, and the Figs. 1, *b*) and 1, *c*) show the ideograms of the projected spectra on the $K\pi$ and $Y\pi$ axes.

Figure 1, *d*) shows the squared effective mass spectrum of the $K\pi$ system for the events of groups $B+C$. This last spectrum is consistent with the ordinary phase-space drawn in the diagram.

Instead of that, the spectrum of Fig. 1, *b*) for the events with an $I=\frac{1}{2}$, state favored *a priori*, shows a dominant production of K*. The distribution of the K* events in the Dalitz plot does not show any interference with the $Y_1^*(1385)$ that appears in the $Y\pi$ system. There is also a bump at 1125 MeV, with little statistical significance, although in the Dalitz plot two bands in correspondence with both peaks are clearly seen.

We tried to fit the $M^2(K\pi)$ spectrum of Fig. 1, *b*) with a combination of K* and phase space, modified in order to take into account the $Y_1^*(1385)$ and subject to the constraint of the proportion of Λ's and Σ's. The result of the fit indicates 54% of K*(891) and 46% of phase space, and it was drawn in the figure.

Fig. 2, *a*) shows the Chew-Low diagram for the events of group A, and Fig. 2, *b*) shows the spectrum of the four-momentum transfer to the baryon. Small momentum transfers are preferred, and together with the known forward production, there appears a small group of events of low mass, produced backward with high momentum transfer.

The curve drawn in (*b*) was made on the basis of the peripheral model [7],

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[7] G. F. Chew and F. A. Low: *Phys. Rev.*, **113**, 1640 (1959).

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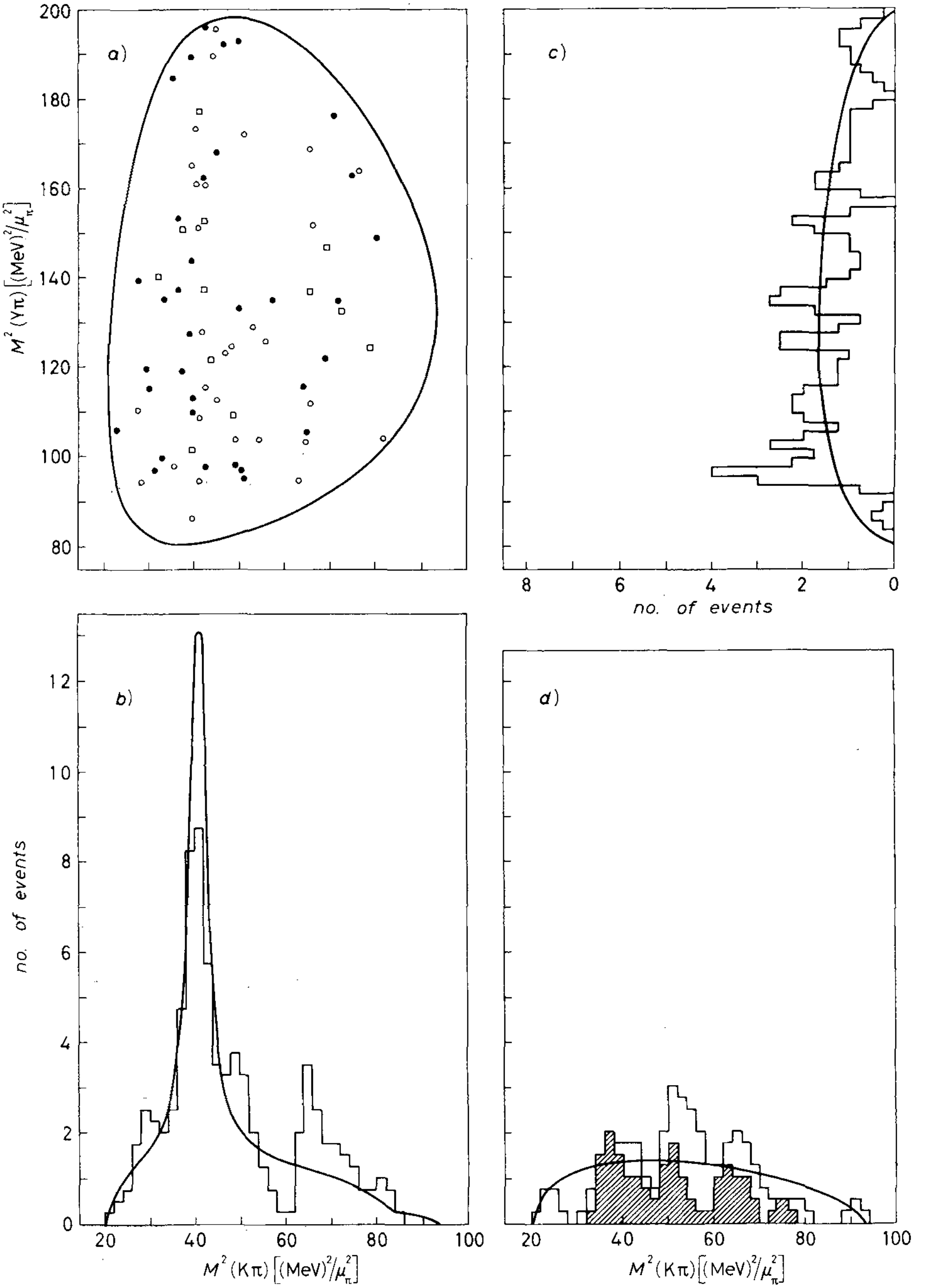

Fig. 1. – *a*) Dalitz plot for events with K* favored by isotopic spin; *b*) and *c*) are the projected spectra, the curves being the best fit and the ordinary phase space, respectively; *d*) squared effective mass spectrum for events with $I=\frac{1}{2}$ not favored *a priori*. • $\Sigma^-K^0\pi^+$; ▫ $\Sigma^0K^+\pi^-$; ○ $\Lambda^0K^+\pi^-$; ▨; $\Sigma^-K^+\pi^0$ and $\Lambda^0K^0\pi^0$; ▭; $\Sigma^+K^0\pi^-$; 76 events.

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where the exchanged particle is a K meson (one K exchange model OKE). The experimental spectrum is more peaked than the theoretical prediction. That is a result already known from pion production, where the reaction seems

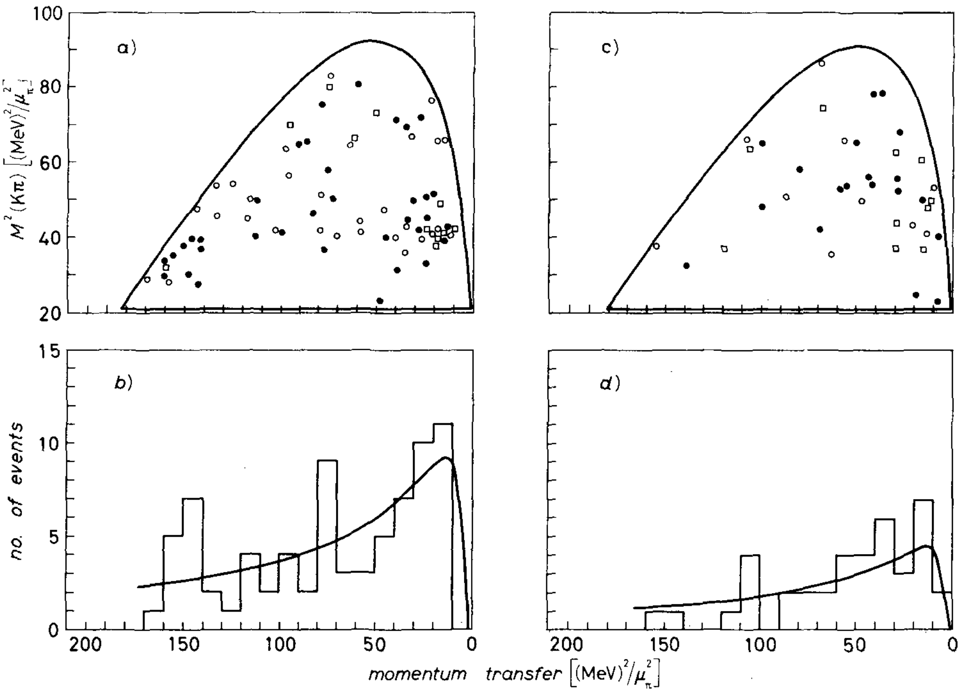

Fig. 2. – *a*) Chew-Low diagram for events of group *A*; *b*) projected spectrum of Δ^2. The curve represents the ordinary peripheral-model prediction; *c*) Chew-Low diagram for events of groups $B+C$; *d*) projected spectrum of Δ^2. The curve is the ordinary peripheral-model prediction. *a*) • $\Sigma^- K^0 \pi^+$; □ $\Sigma^0 K^+ \pi^-$; ○ $\Lambda^0 K^+ \pi^-$; *e*) • $\Sigma^+ K^0 \pi^-$; □ $\Sigma^- K^+ \pi^0$; ○ $\Lambda^0 K^0 \pi^0$.

also to be « more peripheral than the peripheral model » [8], and where the disagreement was tentatively solved with form factors [9] or with the absorptive model [10].

Figs. 2, *c*) and 2, *d*) are the corresponding diagrams for the events of groups $B+C$. There appears to be a better agreement with the ordinary OKE model

[8] N. Schmitz: *Proceedings of the 1965 Easter School for Physicists*, CERN 65-24 (1965), p. 28.

[9] E. Ferrari and F. Selleri: *Nuovo Cimento*, **21**, 1028 (1961); **27**, 1450 (1963); F. Selleri: *Phys. Lett.*, **3**, 76 (1962).

[10] H. Pilkuhn: *Proceedings of the 1965 Easter School for Physicist*, CERN 65-24 (1965), p. 28.

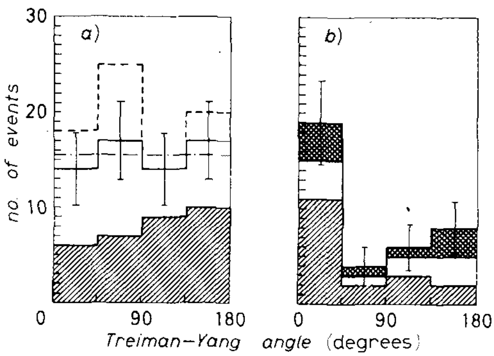

Fig. 3. – Treiman-Yang angle distribution for events of *a*) group *A* and *b*) groups $B+C$: *a*) [dashed]; bump, [hatched] ; K* peak, [open]; other, $c=0$, $c'=0$; *b*) [cross-hatched]; $\Lambda^0 K^0 \pi^0$; [open]; $\Sigma^- K^+ \pi^0$, [hatched]; $\Sigma^+ K^0 \pi^-$, $c=0.24$, $c'=0.46$.

In Fig. 3, *a*) the distribution of the Treiman-Yang angle [11] ($\Phi_{\text{T-Y}}$) for the events of group *A* is shown. With the only exception of the events corresponding to the bump in the $M^2(\text{K}\pi)$ spectrum ($62 < M^2(\text{K}\pi) < 76$), which were drawn with a dashed line at the top of the diagram, the distribution for the other events seems to be uniform, that is, the necessary condition imposed by the Treiman-Yang test to the OKE model is fulfilled.

We have defined two parameters c and c' to give a global measure of two different kinds of departure from isotropy. The parameter c is defined to measure an effect similar to the forward-backward asymmetry in the oridnary angular distributions:

$$c = \frac{N_1 - N_2}{N_1 + N_2},$$

N_1: no. of events with $\Phi_{\text{T-Y}} < 90°$,

N_2: no. of events with $\Phi_{\text{T-Y}} > 90°$.

The coefficient c' is defined to measure the coplanarity of the two relevant planes of the Yang-Treiman test (the Y-p and the K-π planes):

$$c' = \frac{N_3 - N_4}{N_3 + N_4},$$

N_3: no. of events with $0° < \Phi_{\text{T-Y}} < 45°$ or $135° < \Phi_{\text{T-Y}} < 180°$,

N_4: no. of events with $45° < \Phi_{\text{T-Y}} < 135°$.

Both coefficients are zero for the events of group *A* (that of the bump excluded).

In Fig. 3, *b*) the corresponding distribution for the events of groups $B+C$ is shown. It is significantly different from the preceding one, departing from isotropy ($c = 0.24 \pm 0.16$; $c' = 0.46 \pm 0.15$). That is, the events of groups *B* and *C* do not seem to be consistent with the OKE model.

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(11) S. B. Treiman and C. N. Yang: *Phys. Rev. Lett.*, **8**, 140 (1962).

For completeness, in Fig. 4, *a*) the spectrum of the squared effective mass for the $Y\pi$ system was represented, for the events of reactions (2), (3), (4) and (5), for which that system can not be in a $I=0$ state. The curve represents the ordinary phase-space. A fit to the experimental data gives 14 % of $Y_1^*(1385)$ and 86 % of phase space (modified in order to take into account the $K^*(891)$).

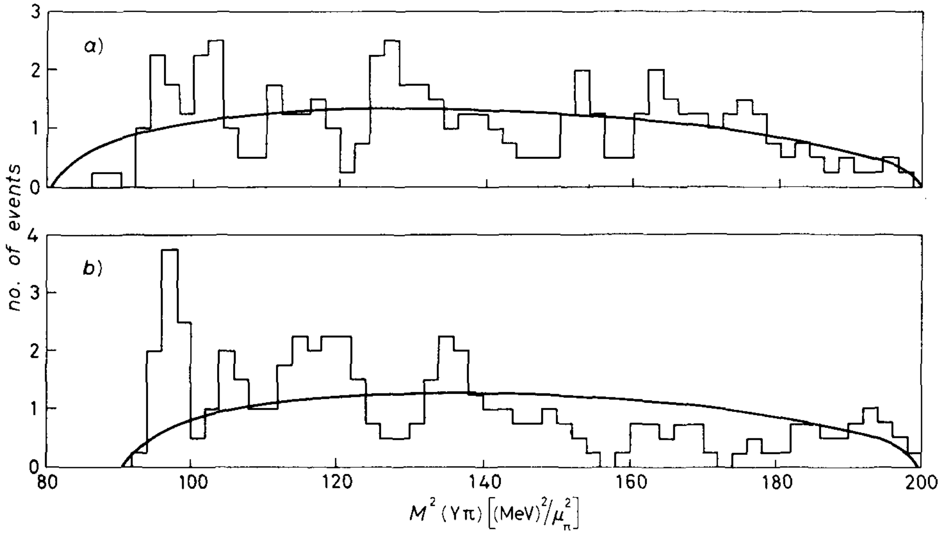

Fig. 4. – Squared effective mass distribution for *a*) events in which the $Y\pi$ system can not be in $I=0$ and *b*) events for which $I=0$ is possible. The curves are ordinary phase-space. *a*) $\Sigma^0K^+\pi^-$, $\Lambda^0K^+\pi^-$, $\Sigma^-K^+\pi^0$, $\Lambda^0K^0\pi^0$, 61 events; *b*) $\Sigma^-K^0\pi^+$, $\Sigma^+K^0\pi^-$, 54 events.

In Fig. 4, *b*) the $M^2(Y\pi)$ was represented for events in which the $Y\pi$ system may be in a $I=0$ state. The curve represents the ordinary phase-space. The peak at low energies is assigned to the $Y_0^*(1405)$, although it appears at 1375 MeV, as was also found in a similar experience by MILLER *et al.* [1]. A fit to the experimental data gives 17 % of $Y_0^*(1405 \to 1375)$, 14 % of $Y_0^*(1520)$ and 69 % of phase space (modified to take into account the K^*).

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RIASSUNTO (*)

Si è studiata la produzione di particelle strane nelle reazioni $\pi^- + p$ a 2.75 GeV/c. Si presentano i risultati riguardanti lo stato finale a tre corpi. Si determina con procedimenti di migliore approssimazione il rapporto di produzione delle differenti risonanze conosciute. Si è trovato l'$Y_0^*(1405)$ a 1375 MeV, dove è stato anche trovato da Miller *et al.* Si è controllato il modello di scambio periferico di un K con il metodo di Treiman-Yang, ottenendo compatibilità quando è favorita la produzione del $K^*(891)$. Si è trovato che la sezione d'urto totale è $\sigma_T = (1.4 \pm 0.1)$ mb.

(*) *Traduzione a cura della Redazione.*

Рождение странных уастиц при 2.75 ГэВ/с.
I. Конечное состояние YKπ.

Резюме автпрпм не представлено.

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