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K^+d INTERACTIONS AT 2.3 BeV/c

Berkeley, California

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(To be presented at the 1964 International Conference on High Energy Physics, Dubna, U.S.S.R. August 5–15, 1964)

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(Presented by Sulamith Goldhaber)

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Peripheral K^+n collisions leading to K^* production permit a detailed study of the dynamics of single particle exchange. It was demonstrated in an earlier K^+p experiment at 1.96 BeV/c that the distribution in the K,K scattering angle (in the K^* center of mass) is an effective analyzer of the K^* spin of the exchange particle.[1] In the reaction

$$K^+ + p \rightarrow K^{*o} + N^{*++} \qquad (1)$$

the observed $\cos^2\alpha$ distribution in the KK scattering angle, α, is evidence for an aligned K^* with m = 0 along the K^+ direction (K^* c.m.). The alignment in turn can be understood if the spin of the exchange particle is 0^-.

On the other hand, for the reaction

$$K^+ + p \rightarrow K^{*+} + p \qquad (2)$$

evidence for the presence of vector meson exchange was obtained[2] by observing a considerable contribution of $\sin^2\alpha$ to the angular distribution of the KK scattering angle. A $\sin^2\alpha$ distribution arises for an aligned spin of the K^* with m = ± 1 along the K^+ direction ($|P_1^1|^2$, $|P_1^{-1}|^2$). This problem was studied by Jackson and Pilkuhn[3] who compared the data on reaction (2)

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at 1.96 and 3 BeV/c.[4] They estimated that ~60 and 90% of the respective cross sections could be attributed to vector meson exchange for these two momenta.

We are presently studying the K^+d interaction at 2.3 BeV/c. This experiment allows direct comparison of K^{*+} with K^{*o} under the same kinematical conditions. The reactions are:

$$K^+ + p + (n) \rightarrow K^o + \pi^+ + p + (n) \qquad (3)$$

and

$$K^+ + n + (p) \rightarrow K^+ + \pi^- + p + (p) \qquad (4)$$

The Feynman diagrams applicable to reactions (3) and (4) (see Fig. 1), differ in that for (3) isoscalar as well as isovector particles can be exchanged (e.g. π^o, ρ^o, ω^o) while for (4) only isovector particles can be exchanged (e.g. $\pi^\pm$, $\rho^\pm$). Furthermore, reaction (4) may afford a test of the validity of "A" invariance, a selection rule for bosons proposed by Bronzon and Low.[5] This selection rule ascribes the quantum numbers $A_\pi = A_K = A_\omega = -1$ and $A_\rho = A_{K^*} = 1$ to the π, K, ω, ρ, and K^* respectively. Thus, ρ exchange in either of the two reactions would violate this selection rule.

The experiment described here was carried out in the 20-inch Brookhaven National Laboratory bubble chamber filled with deuterium, exposed in the Brookhaven-Yale separated beam. In Figs. 2, 3, and 4 we present our preliminary results on the comparison between the angular distributions of the K^{*+} and K^{*o} respectively produced in the two reactions. We have defined the K^* as the invariant $K\pi$ mass between 840 and 940 MeV. We find in reaction (3) 39% of all events to be in this mass region whereas in reaction (4) 47% fall into this mass interval. In Fig. 2 we show the Dalitz plots corresponding

to the two reactions. To describe the angular distribution, we have defined the following coordinate system in the K^* center of mass: the direction of the incident K meson, $\hat{k}$, the normal of the production plane, $\hat{n}$, and the mutually perpendicular $\vec{\epsilon} = \hat{n} \times \hat{k}$. In Fig. 3 we show the KK scattering angle, α, in the K^* center of mass. The angular distribution of the direction of the K with the normal of the production plane is given in Fig. 4. The Treiman-Yang angle at the K^* vertex is given in Fig. 5. For the exchange of a 0^- particle we expect the distributions $\cos^2\alpha$, $\sin^2\gamma$ and isotropic in ϕ. Reaction (4) appears to be dominated by the exchange of a 0^- particle while reaction (3) indicates considerable amount of vector exchange as has been noted in earlier experiments. We note here that the angular distribution in the neutral K^* shows a considerable amount of asymmetry.

In Fig. 6 we show the Δ^2 distribution for the two reactions. It is noteworthy that reaction (4) which is consistent with a 0^- particle exchange on the basis of the angular distributions has a considerably narrower Δ^2 distribution.

REFERENCES

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3. J. D. Jackson and H. Pilkuhn, to be published.

4. G. R. Lynch, M. Ferro-Luzzi, R. George, Y. Goldschmidt-Clermont, V. P. Henri, B. Jonejans, D. W. G. Leith, F. Muller, J. M. Perreau, Physics Letters 9, 359 (1964).

5. J. B. Bronzon and F. E. Low, Phys. Rev. Lett 12, 522 (1964).

FIGURE CAPTIONS

Fig. 1. Feynman diagrams for reactions (3) and (4).

Fig. 2. Dalitz plots for reactions (3) and (4).

Fig. 3. Distribution in K, K scattering angle in K^* center of mass.

Fig. 4. Distribution in the angle between the outgoing K meson and the normal to the production plane in the K^* center of mass.

Fig. 5. Distribution in the Treiman-Yang angle at the K^* vertex.

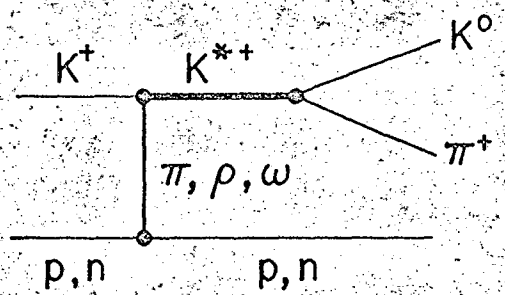
Fig. 6. Four-momentum transfer distributions for reactions (3) and (4)

Isoscalar or isovector exchange

$K^+ + p(n) \longrightarrow K^{*+} + p(n)$

$K^+ + n(p) \longrightarrow K^{*+} + n(p)$

$K^{*+} \longrightarrow K^o + \pi^+$

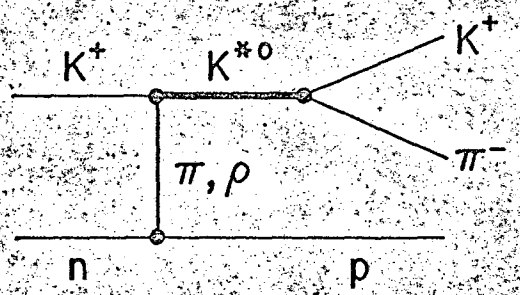


(a)

Isovector exchange

$K^+ + n(p) \longrightarrow K^{*o} + p(p)$

$K^* \longrightarrow K^+ + \pi^-$



(b)

Figure 1

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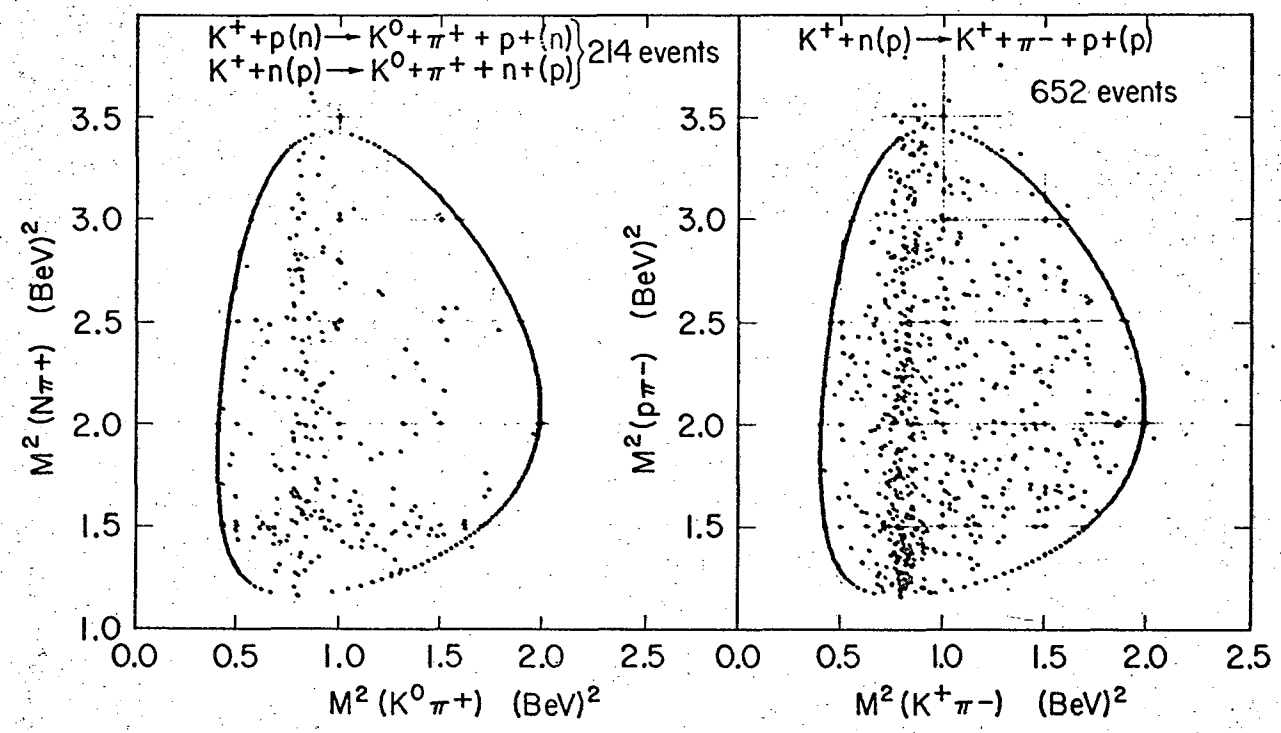
K+ + p(n) → K0 + π+ + p + (n)
K+ + n(p) → K0 + π+ + n + (p)
214 events
K+ + n(p) → K+ + π− + p + (p)
652 events
M2 (Nπ+) (BeV)2
M2 (pπ−) (BeV)2
M2 (K0π+) (BeV)2
M2 (K+π−) (BeV)2
1.0
1.5
2.0
2.5
3.0
3.5
0.0
0.5
1.0
1.5
2.0
2.5
MUB-3627

Figure 2

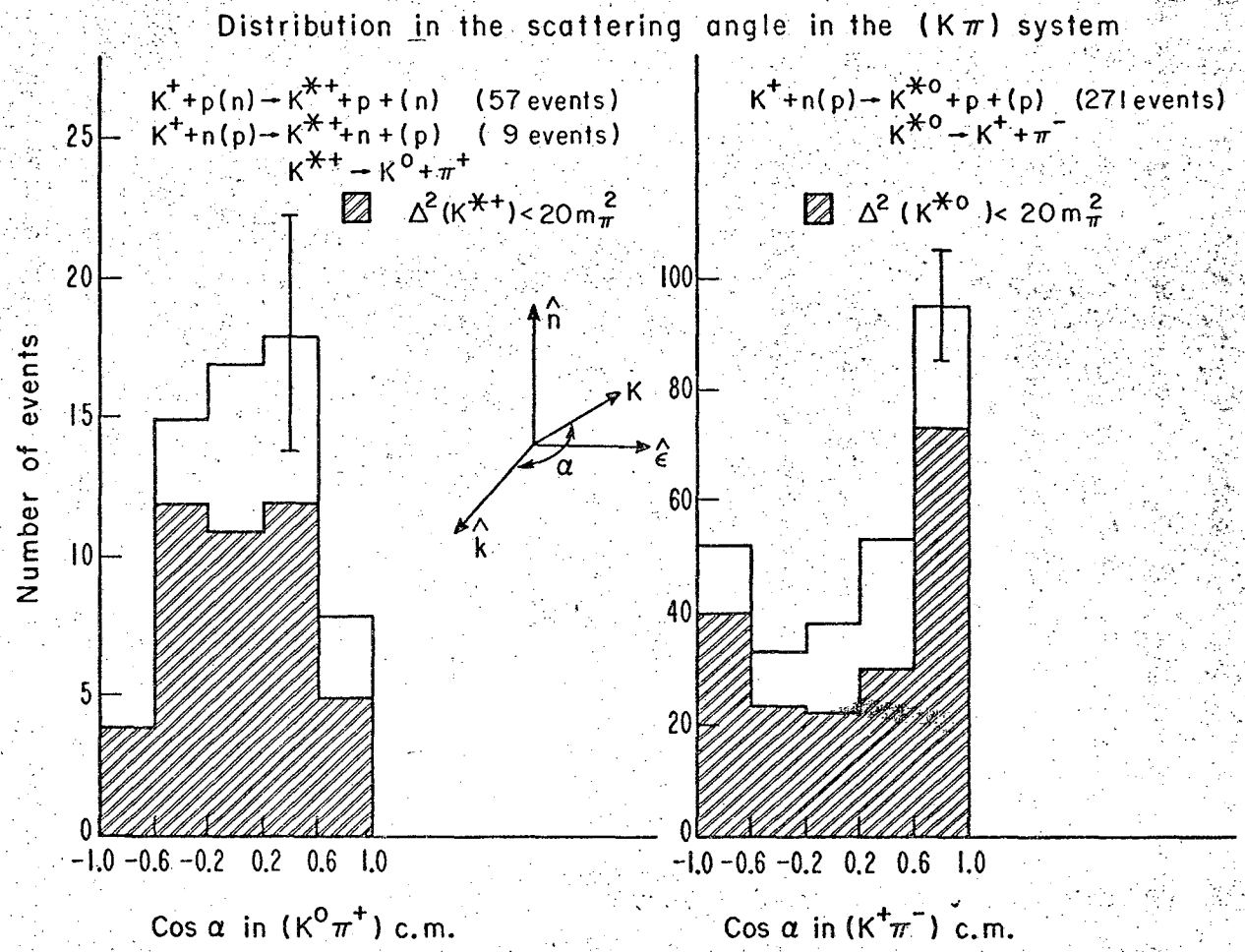
Distribution in the scattering angle in the (Kπ) system
K+ + p(n) → K*+ + p + (n) (57 events)
K+ + n(p) → K*+ + n + (p) (9 events)
K*+ → K0 + π+
Δ2(K*+) < 20mπ2
K+ + n(p) → K*0 + p + (p) (271 events)
K*0 → K+ + π−
Δ2 (K*0) < 20mπ2
Number of events
n̂
K
ε̂
α
k̂
Cos α in (K0π+) c.m.
Cos α in (K+π−) c.m.
MUB-3625

Figure 3

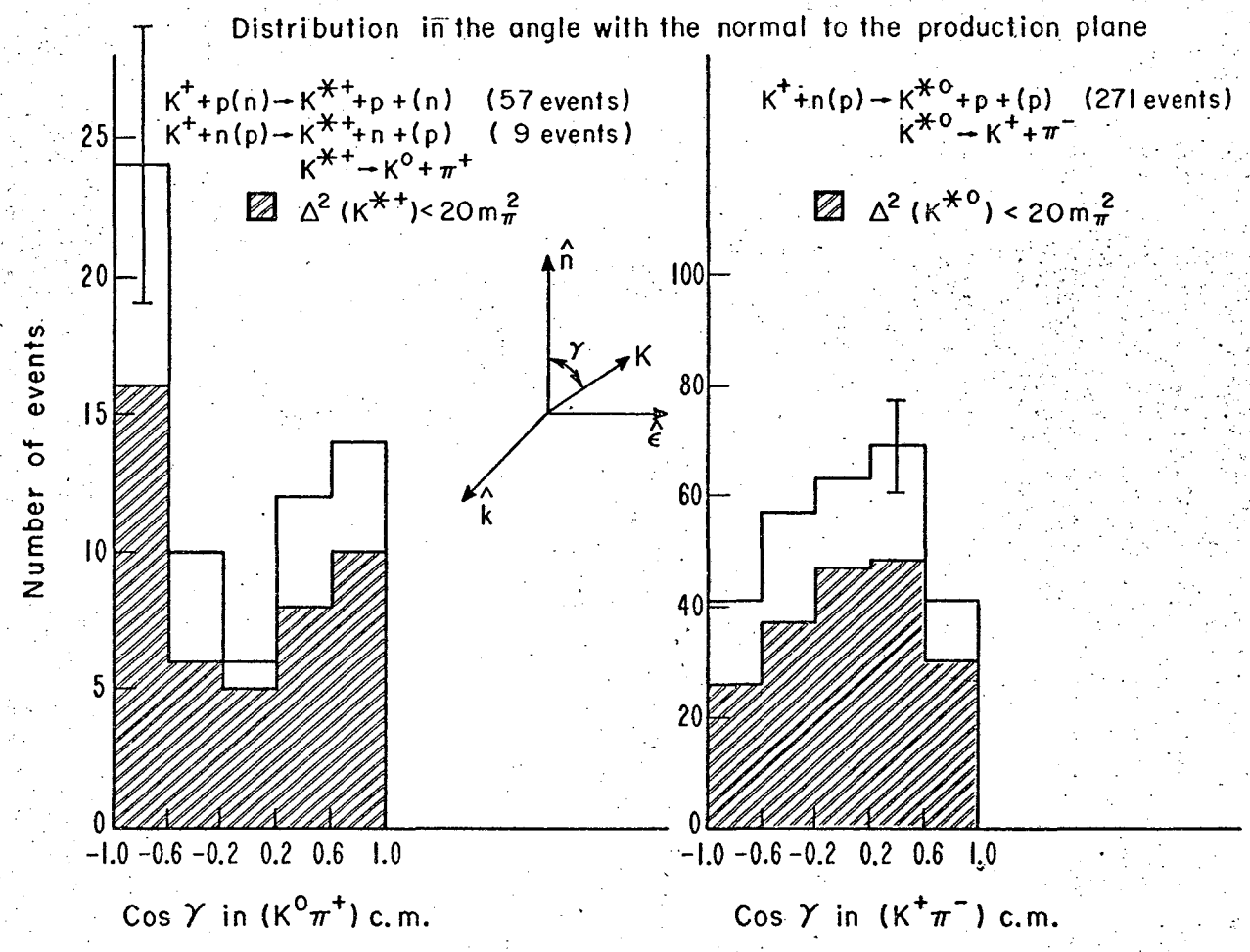
Distribution in the angle with the normal to the production plane
$K^+ + p(n) \rightarrow K^{*+} + p + (n)$ (57 events)
$K^+ + n(p) \rightarrow K^{*+} + n + (p)$ (9 events)
$K^{*+} \rightarrow K^0 + \pi^+$
$\Delta^2 (K^{*+}) < 20 m_\pi^2$
$K^+ + n(p) \rightarrow K^{*0} + p + (p)$ (271 events)
$K^{*0} \rightarrow K^+ + \pi^-$
$\Delta^2 (K^{*0}) < 20 m_\pi^2$
Number of events
Cos γ in $(K^0\pi^+)$ c.m.
Cos γ in $(K^+\pi^-)$ c.m.
MUB-3626

Figure 4

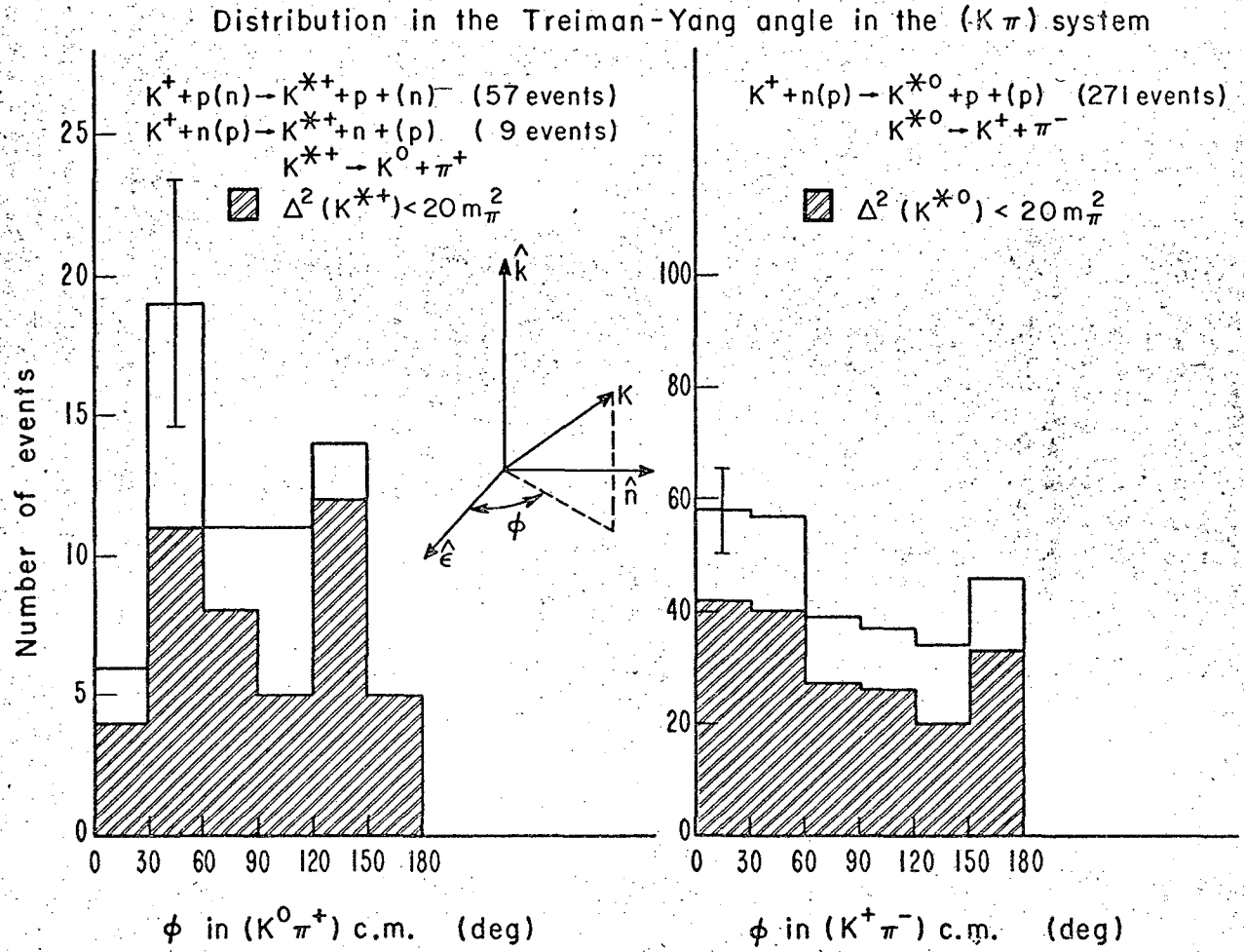
Distribution in the Treiman-Yang angle in the (Kπ) system
K+ + p(n) → K*+ + p + (n) (57 events)
K+ + n(p) → K*+ + n + (p) (9 events)
K*+ → K0 + π+
Δ2 (K*+) < 20 mπ2
K+ + n(p) → K*0 + p + (p) (271 events)
K*0 → K+ + π−
Δ2 (K*0) < 20 mπ2
Number of events
k̂
K
n̂
ε̂
φ
φ in (K0π+) c.m. (deg)
φ in (K+π−) c.m. (deg)
0 30 60 90 120 150 180
MUB-3624

Figure 5

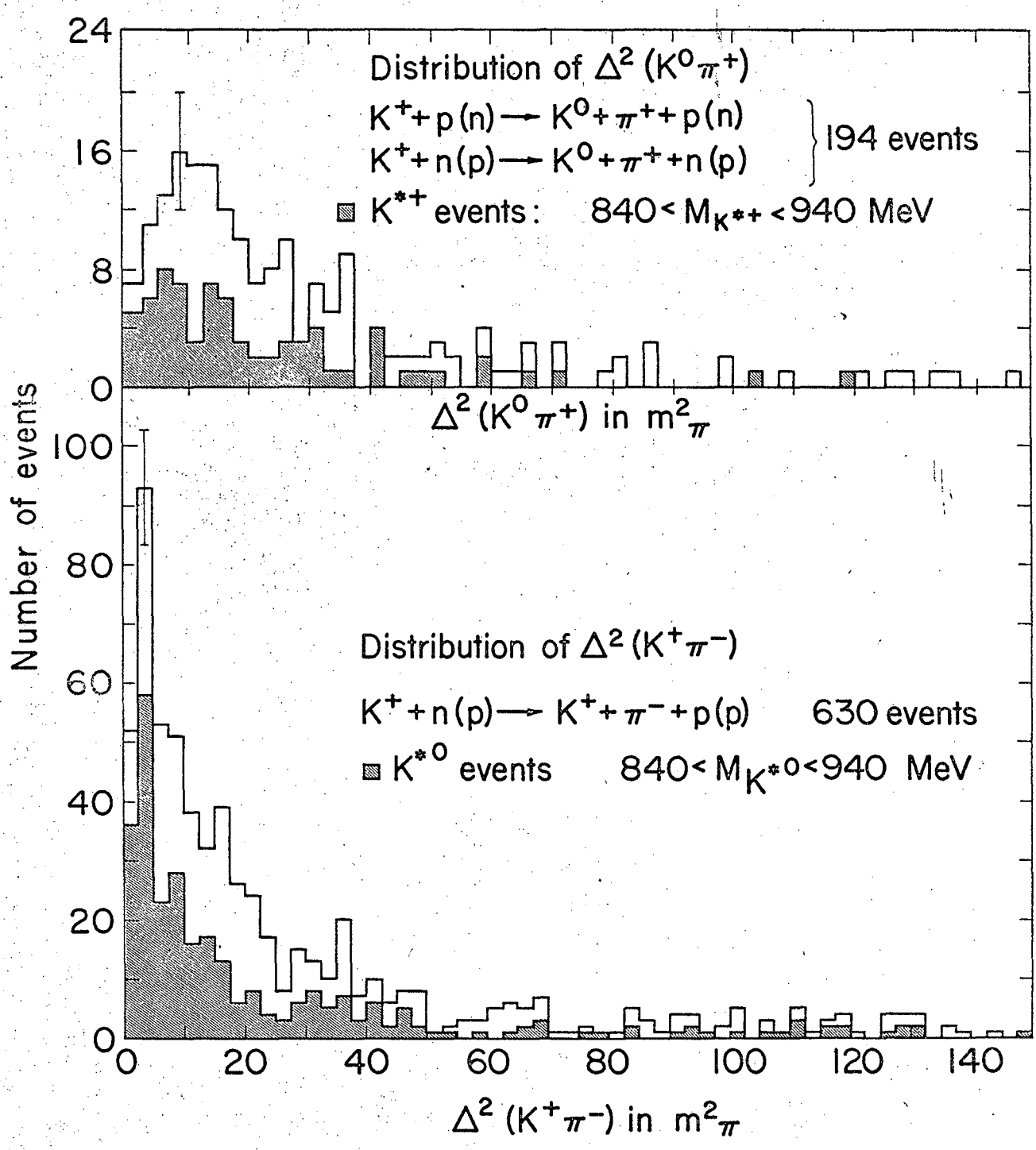

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Figure 6