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K+d INTERACTIONS AT 2.3 BeV/c

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K^+d INTERACTIONS AT 2.3 BeV/c

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Berkeley, California

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K^+ INTERACTIONS AT 2.3 BEV/C

Sulamith Goldhaber, Ian Butterworth, Gerson Goldhaber, Allan A. Hirata,
John A. Kadyk, Thomas A. O'Halloran, Benjamin C. Shen, and George H. Trilling

July 24, 1964

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K^+ d INTERACTIONS AT 2.3 BEV/c*

Sulamith Goldhaber, Ian Butterworth, Gerson Goldhaber, Allan A. Hirata,
John A. Kadyk, Thomas A. O'Halloran, Benjamin C. Shen, and George H. Trilling

(Presented by Sulamith Goldhaber)

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University of California
Berkeley, California

July 24, 1964

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



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



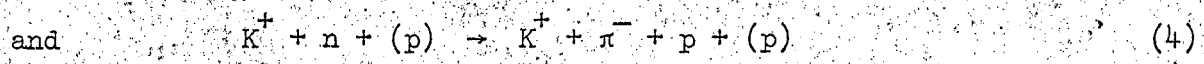
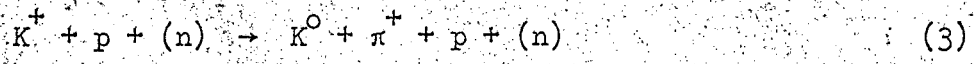
evidence for the presence of vector meson exchange was obtained² by observing a considerable contribution of $\sin^2 \alpha$ to the angular distribution of the KK scattering angle. A $\sin^2 \alpha$ distribution arises for an aligned spin of the K^* with $m = \pm 1$ along the K^+ direction ($|P_{\frac{1}{2}}^1|^2, |P_{\frac{1}{2}}^{-1}|^2$). This problem was studied by Jackson and Pilkuhn³ who compared the data on reaction (2)

* Work sponsored by the U. S. Atomic Energy Commission.



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^{*0} under the same kinematical conditions. The reactions are:



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^0 , ρ^0 , ω^0) while for (4) only isovector particles can be exchanged (e.g. π^\pm , ρ^\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^{*0} 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 $\vec{e} = \hat{n} \times \hat{k}$. 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.

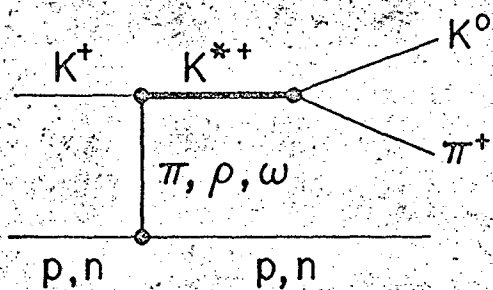
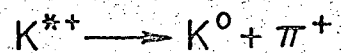
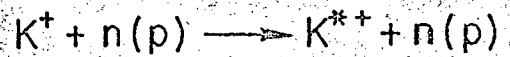
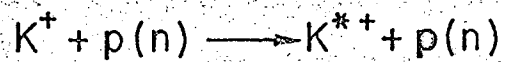
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FIGURE CAPTIONS

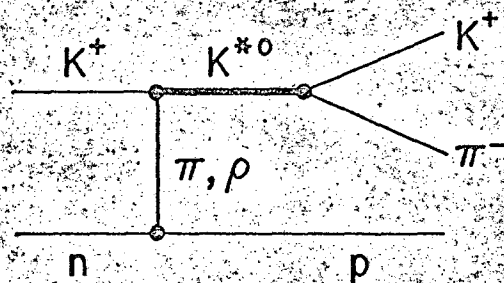
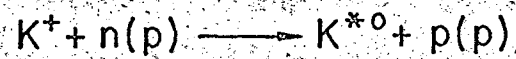
- Fig. 1. Feynman diagrams for reactions (3) and (4).
- Fig. 2. Dalitz plots for reactions (3) and (4).
- Fig. 3. Distribution in K, K scattering angle in K^* center of mass.
- Fig. 4. Distribution in the angle between the outgoing K meson and the normal to the production plane in the K^* center of mass.
- 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



(a)

Isovector exchange



(b)

Figure 1

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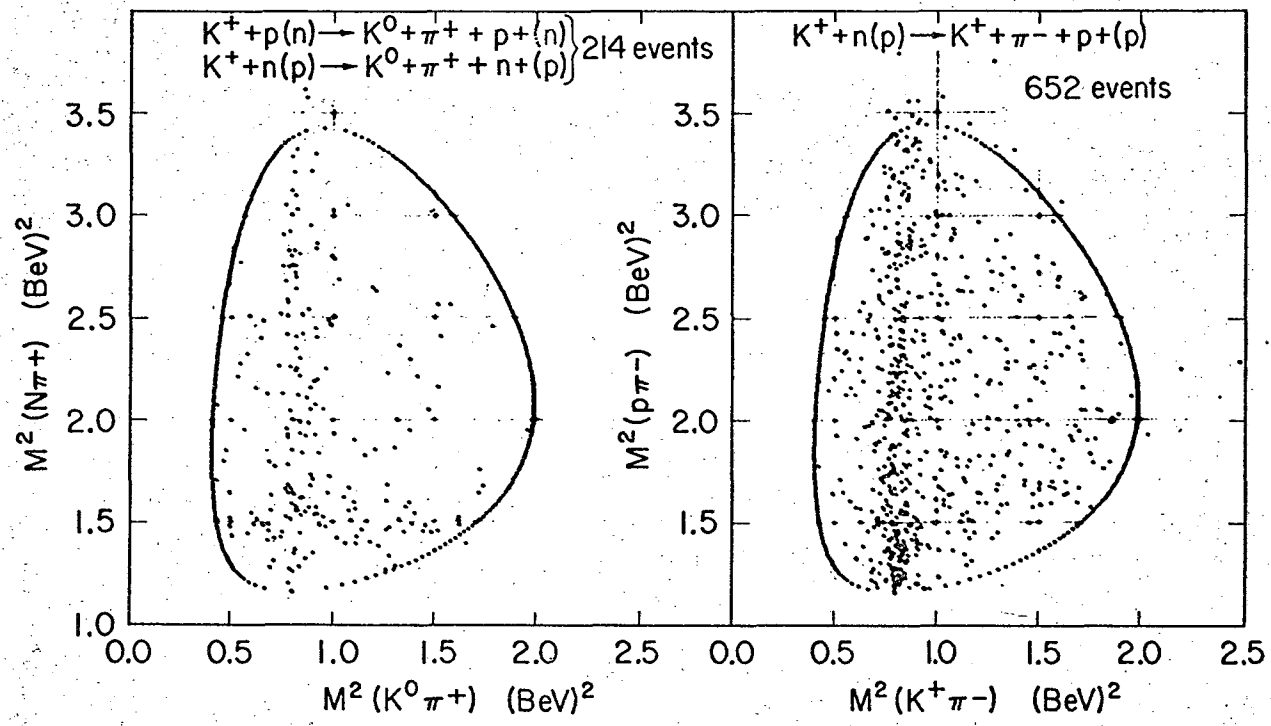
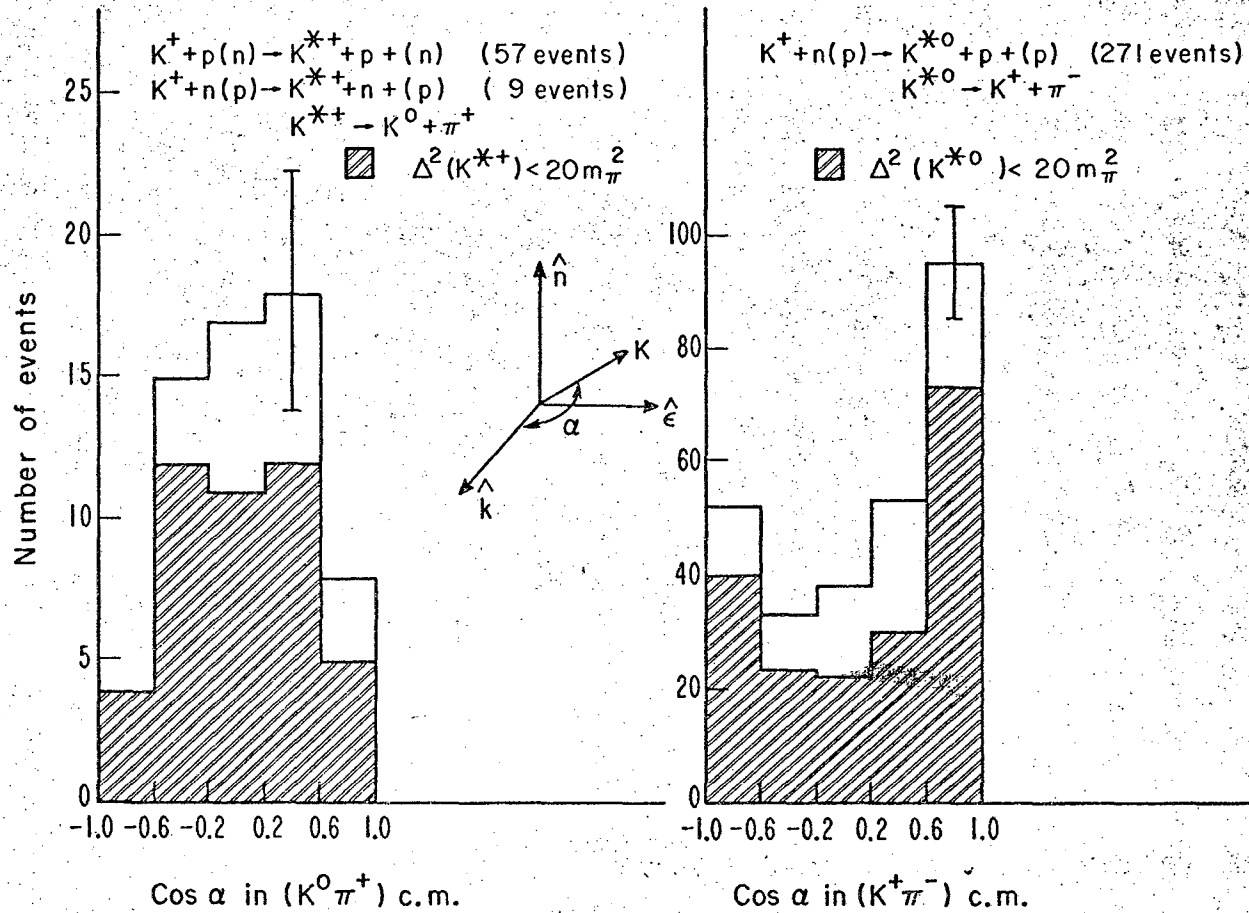


Figure 2

Distribution in the scattering angle in the $(K\pi)$ system



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Figure 3

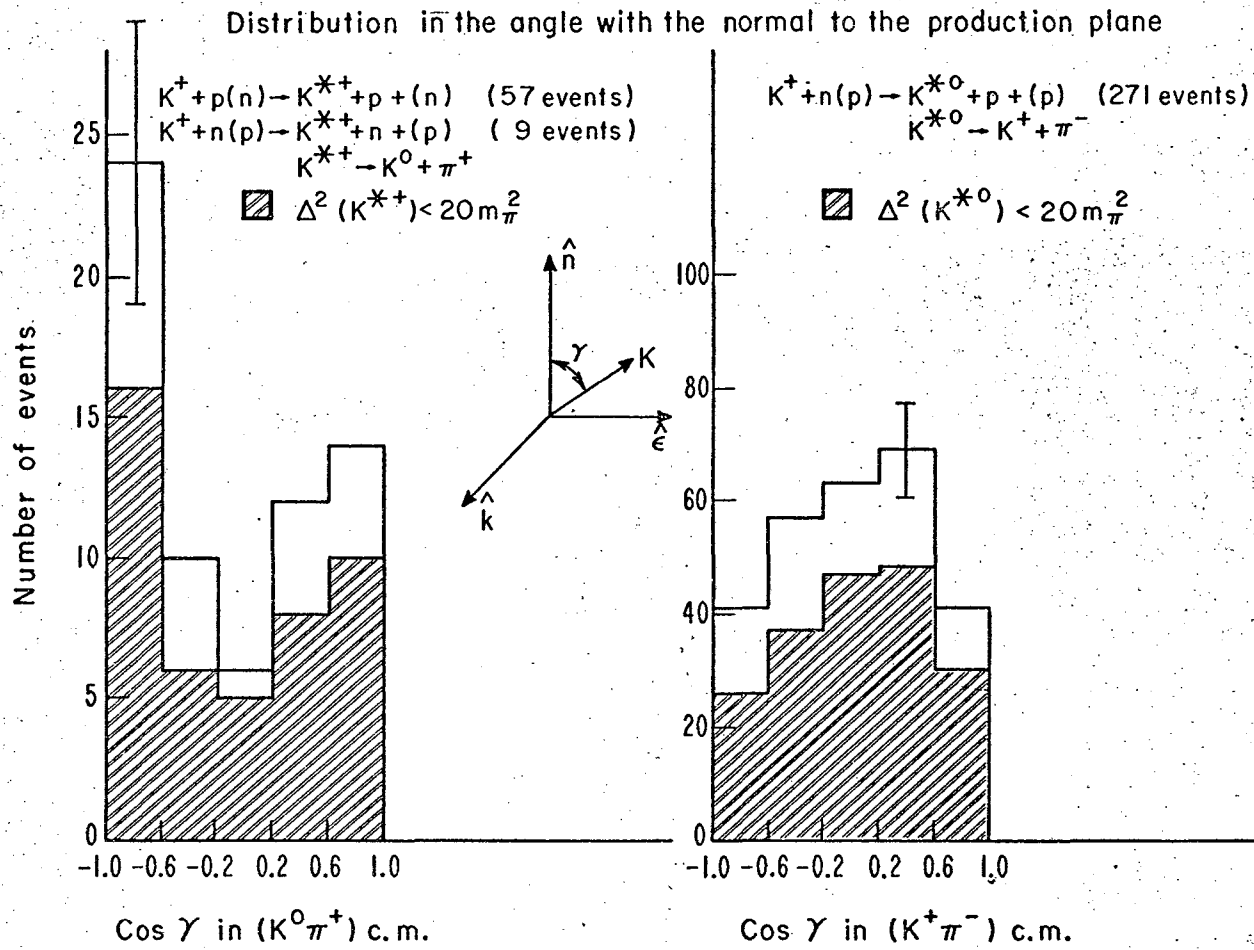


Figure 4

Distribution in the Treiman-Yang angle in the $(K\pi)$ system

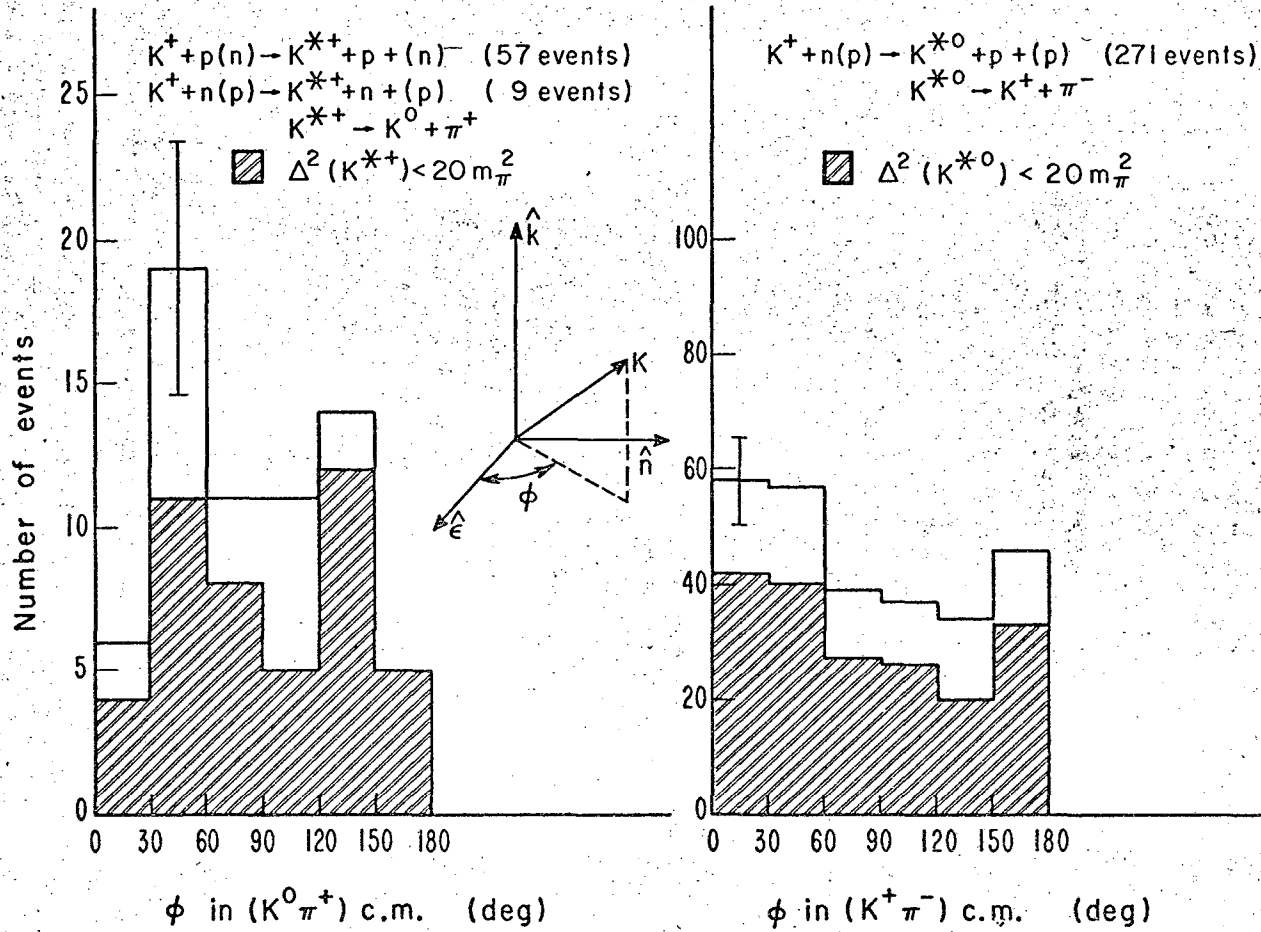


Figure 5

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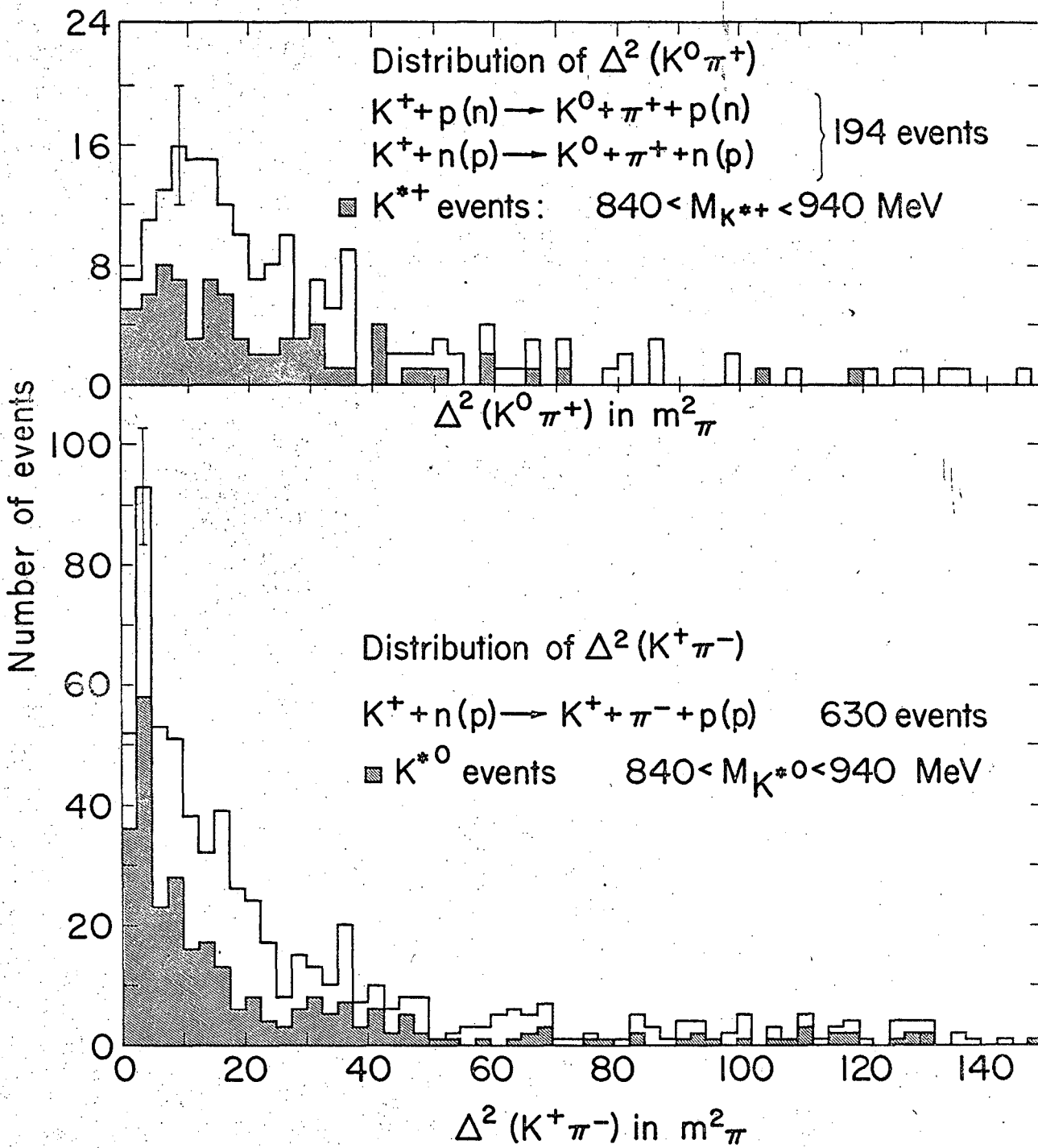


Figure 6

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