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Influence of Peripheral Resonance Production on Angular Correlations Between Pions

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Following the results of Jain *et al.* in K^+p interactions at 12.7 GeV/c, we point out that a way to suppress the influence of peripheral resonances on angular correlations between pions is to investigate the P_T-plane correlations. Results from $\bar{p}p$ interactions at 6.94 GeV/c are given as an example.

In a recent publication, Jain *et al.*[1] reached the conclusion that angular correlations between pions [GGLP (Goldhaber, Goldhaber, Lee, and Pais) effect] in the reaction $K^+p \rightarrow K^+p2\pi^+2\pi^-$ at 12.7 GeV/c are mainly due to the presence of the peripherally produced K^{*0} and Δ^{++} resonances. However, a different explanation has been proposed by Eskreys *et al.*[2] for the same reaction at 8.25 GeV/c. In this case, the GGLP effect would be caused by the difference between the two-particle mass distributions for like and unlike pions. As the two explanations could be related by the kinematic reflection of resonance production on the two-particle mass distributions, it is felt that further tests along this line should be performed. Such a test will be described below.

Since the production of K^{*0} and Δ^{++} in $K^+p \rightarrow K^+p2\pi^+2\pi^-$ at 8.25 GeV/c has been found to be 0.44 ± 0.03 and 0.24 ± 0.04, respectively,[2] we feel that the removal of those resonances from the reaction constitutes a somewhat drastic procedure. The uncertainty due to the arbitrariness of mass cuts and to the combinatorial background should also be taken into account.

A method which has been tried in the analysis of the reactions $\bar{p}p \rightarrow \bar{p}p2\pi^+2\pi^-$ and $\bar{p}p \rightarrow \bar{p}p2\pi^+2\pi^-\pi^0$ at 6.94 GeV/c[3] could provide an interesting alternative. In order to minimize the influence of resonance production, angular correlations should be studied in a plane perpendicular to the line of flight of the resonance. Since the resonances here considered (in this case, Δ^{++} and $\bar{\Delta}^{--}$) are produced peripherally, a good compromise is to use the P_T (transverse momenta) plane. The values of the γ parameters obtained for the pions are given in Table I. The values given by simple phase space are also indicated. The parameter η gives a measure of the over-all deviation of γ^{like} and γ^{unlike} from phase space:

$$\eta = |\gamma^{\text{like}} - \gamma^{\text{phase space}}| + |\gamma^{\text{unlike}} - \gamma^{\text{phase space}}| . \quad (1)$$

TABLE I. Angular-correlation parameters for the transverse momenta of outgoing pions for the reactions $\bar{p}p \rightarrow \bar{p}p2\pi^+2\pi^-$ and $\bar{p}p \rightarrow \bar{p}p2\pi^+2\pi^-\pi^0$ at 6.94 GeV/c.

	(1) $\gamma(\pi^\pm\pi^\pm)$	(2) $\gamma(\pi^+\pi^-)$	(3) $\gamma(\pi^\pm\pi^0)$	(2) + (3)	γ(phase space)	η
$\bar{p}p \rightarrow \bar{p}p2\pi^+2\pi^-$	1.05 ± 0.09	1.43 ± 0.09	···	···	1.23	0.38 ± 0.13
$\bar{p}p \rightarrow \bar{p}p2\pi^+2\pi^-\pi^0$	1.10 ± 0.11	1.23 ± 0.09	1.40 ± 0.10	1.31 ± 0.07	1.18	0.21 ± 0.13

By comparing the results given in Table I with those obtained by a standard analysis,[4] one sees that the effect remains of the same order of magnitude. We therefore feel that it would be worthwhile to extend this kind of analysis to other interactions such as K^+p.

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Effect of Resonance Production on Angular Correlation Between Pions

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We have studied, in the P_t plane, the angular correlations between pions produced in the six-prong interactions of K^+p at 12.7 GeV/c in order to suppress the influence of peripherally produced resonances. These results are compared with the values previously determined using space angles.

In a low-energy $\bar{p}p$ annihilation experiment, Goldhaber *et al.*[1] discovered that the distribution of the c.m. angle between two pions depends on the charges of the pions. The average angle between pions of equal charges $(\pi^\pm\pi^\pm)$ was smaller than in the case of pairs of opposite charge $(\pi^+\pi^-)$ (this is known as the GGLP effect). As a measure of the effect the parameter γ was introduced, where

$$\gamma=\frac{\text{number of pairs with } \theta_{\pi\pi}>90^\circ}{\text{number of pairs with } \theta_{\pi\pi}<90^\circ}$$

such that $\gamma^{+-}>\gamma^{\pm\pm}$. Bose-Einstein statistics were invoked to explain these results, but were found to be inadequate. The GGLP effect has been studied in many experiments[2] and is found to be dependent on the leading particle; for example, (i) $\gamma^{++}>\gamma^{--}$ for primary π^+ and (ii) $\gamma^{--}>\gamma^{++}$ for primary π^-. To avoid the leading-particle effect, we recently[3] studied the interaction $K^+p\to K^+p2\pi^+2\pi^-$ at 12.7 GeV/c. We found that the abundant production of two resonances, N^{*++} and K^{*0}, influences considerably the distribution of the angles between the pions momenta. In Tables I and II are shown the revised values of the γ parameter and the asymmetry parameter A defined by $A=(\gamma-1)/(\gamma+1)$ for different pairs of particles in the reaction $K^+p\to K^+p2\pi^+2\pi^-$. We find that the γ values for exotic combinations of $(\pi^\pm\pi^\pm)$ and $(K^+\pi^+)$ were larger than for nonexotic pairs $(\pi^+\pi^-)$ and $(K^+\pi^-)$, respectively. For the K^+p interaction at 8.25 GeV/c, Eskreys *et al.*[4] have recently concluded that the GGLP effect could be a reflection of the differences in two-particle effective-mass distributions, which are different for like and unlike pairs. We know that the differences in the mass distributions for different pairs of pions are also observed when resonances are produced, which we have already discussed in our previous paper.[3] We do agree with Eskreys *et al.* that the GGLP effect is due to the difference between the mass distributions for like and unlike pairs. However, we believe that the difference in the mass distributions is a result of the resonant effects. We have demonstrated[3] that the presence of resonances plays an important part in determing the GGLP effect.

Recently Schlesinger[5] has pointed out that in order to minimize the influence of the resonances N^{*++} and K^{*0}, which are produced peripherally, the angular distribution should be studied in the