Brief Reports

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Production of low-mass $K^+\omega$ systems on nuclei

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We have measured the coherent nuclear production of low-mass $K^+\omega$ systems in K^+A collisions at 202.5 GeV. Results for carbon, copper, and lead targets are similar to those found for $\pi^+\pi^+\pi^-$ production in π^+A reactions at the same energy.

We have studied the coherent dissociation of 202.5-GeV/c K^+ mesons

$$K^+A \rightarrow K^+\pi^+\pi^-\pi^0 A \quad , \qquad (1)$$
$$\pi^0 \searrow \gamma\gamma$$

where A refers to carbon, copper, or lead nuclear targets. The data were obtained as part of a general investigation of Coulombic and strong exclusive production processes on nuclear targets at high energies.[1-3] The experimental setup has been described in detail elsewhere.[1-5] Here we summarize only the most relevant points.

The trajectory of the beam was defined by several multiwire proportional chambers and scintillation counters. The incident kaon was tagged using a set of three Cherenkov counters. Charged particles downstream of the target were detected and momentum-analyzed using sets of drift and proportional chambers, located both downstream and upstream of a magnet.[4] Positions and energies of photons were measured using a highly segmented liquid-argon shower detector.[5] Veto counters placed around the target, and at the aperture of the magnet, eliminated, at the trigger stage, those incoherent interactions and events with particles outside of the acceptance of the spectrometer. Information from proportional chambers was used, also at the trigger level, to preselect events with a specific number of charged tracks found downstream and upstream of the magnet.

The requirements in the off-line analysis for reaction (1) were the following: (1) the beam particle had to be identified as a K^+ by the Cherenkov counters; (2) three reconstructed tracks of correct charge had to emerge from the target region; (3) two photons had to be reconstructed in the shower detector and have an effective mass consistent with that of the π^0 (within 25 MeV of the π^0 mass); and (4) the total energy of the final-state particles had to be within $\pm 5\%$ of 202.5 GeV, the mean energy of the beam. For the data to be presented, target-empty runs were used to subtract small backgrounds that originated from other than target sources.

In this paper we restrict our investigation of reaction (1) to low $K^+\pi^+\pi^-\pi^0$ masses. This is the mass region that is known to be dominated by the Q_b meson.[6] The data are also restricted to low four-momentum transfers, where production is coherent over the nucleus ($t < t^* = 0.4A^{-2/3}$ GeV^2, where t^* is the approximate position of the first diffractive minimum).

In Fig. 1 we display the distribution of $\pi^+\pi^-\pi^0$ masses in reaction (1) for copper data that have the $K^+\pi^+\pi^-\pi^0$ mass below 1.5 GeV. Because there was no particle identification available downstream of the target, there were consequently two possible mass assignments for each of the positive particles in reaction (1). (Background from K^+ dissociation into $K^+K^+K^-\pi^0$ and $K^+p\bar{p}\pi^0$ systems was ignored.) The unshaded events in Fig. 1 correspond to $\pi^+\pi^-\pi^0$ masses when the K^+ mass is assigned to the positive track with higher momentum (K_h^+), while the cross-hatched events correspond to $\pi^+\pi^-\pi^0$ combinations when the K^+ mass is assigned to the positive track with lower momentum (K_l^+). Clearly, most of the events with small $K^+\pi^+\pi^-\pi^0$ mass have a leading K^+, and involve primarily $K^+\omega$ dissociations. The results for carbon and lead (not shown) are similar to those in Fig. 1.

Figure 2 displays the $K^+\omega$ mass for different nuclear targets for $t < t^*$. The ω was defined by the $\pi^+\pi^-\pi^0$ mass interval between 0.74 and 0.82 GeV. If the $\pi_l^+\pi^-\pi^0$ mass

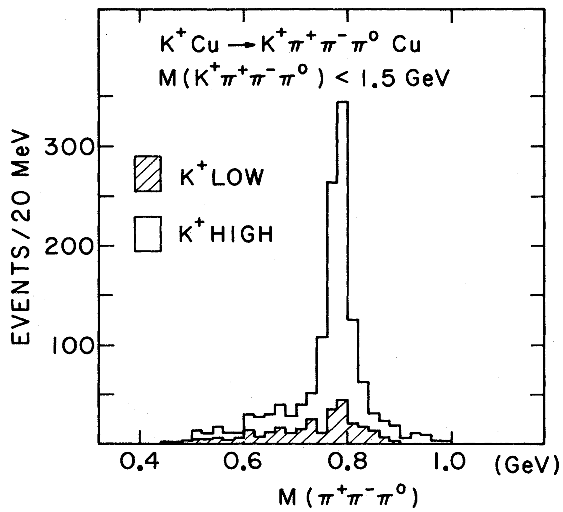

FIG. 1. The $\pi^+\pi^-\pi^0$ mass combinations for low $K^+\pi^+\pi^-\pi^0$ masses in Reaction (1).

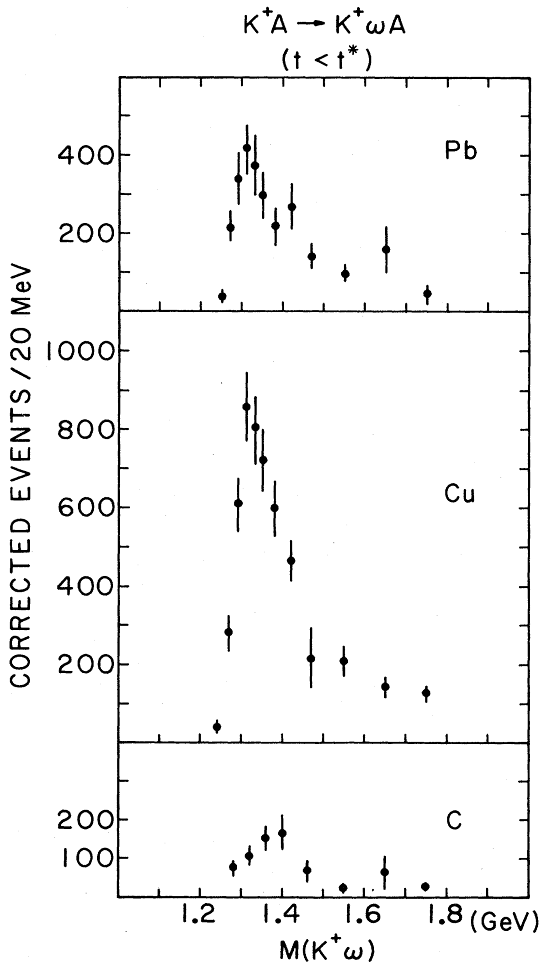

FIG. 2. The $K^+\omega$ mass distributions from the coherent peak for carbon, copper, and lead targets. The data have been corrected for acceptance.

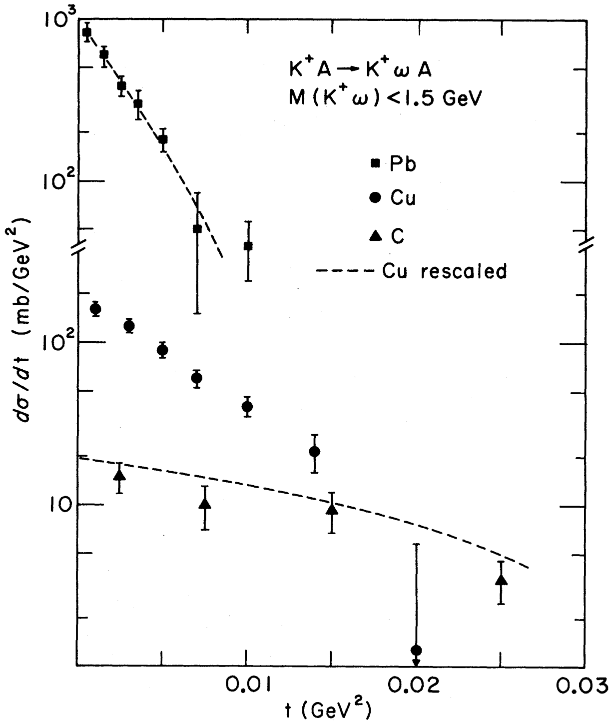

FIG. 3. Differential cross sections for $K^+\omega$ production on carbon, copper, and lead. The curves on Pb and C data are the results for Cu, smoothed and scaled according to expectations of simple geometric ideas.

(i.e., K_h^+ events) was in the ω region, then that was chosen as the ω; if the $\pi_l^+\pi^-\pi^0$ mass was outside the ω interval, but the $\pi_h^+\pi^-\pi^0$ mass (i.e., K_l^+ events) was in the ω range, then the (*a priori* less likely) $\pi_h^+\pi^-\pi^0$ combination was used as the *omega*. The three sets of data in Fig. 2, corrected for geometric acceptance, indicate the presence of a low-mass Q-like peak. (The acceptance is about 14%,

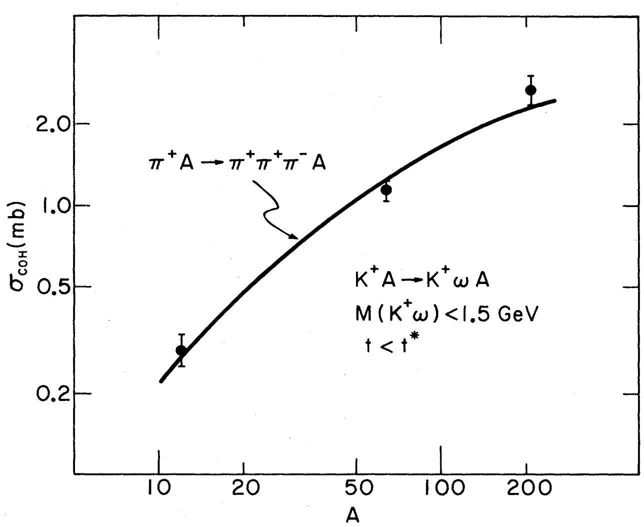

FIG. 4. The A dependence of the integrated cross section for coherent production of low-mass $K^+\omega$ systems. The curve represents the shape of coherent $\pi^+\pi^-\pi^0$ production on nuclear targets (Ref. 3).

essentially independent of mass, between 1.2 and 1.8 GeV.)

Cross sections for the $K^+\omega$ mass region below 1.5 GeV are displayed as a function of t in Fig. 3. The data have been corrected for acceptance and normalized to beam K^+ decays measured in the same experiment. The error bars on the data reflect only statistical uncertainties. The overall absolute normalization is uncertain to $\pm 15\%$, and the target-dependent uncertainty is about $\pm 9\%$. The curves superimposed on the Pb and C data have been obtained by smoothing the Cu data and scaling the cross sections by a geometrically motivated factor $A^{4/3}$ and the t variable by $A^{-2/3}$. We see that scaling in the forward direction is consistent with the $A^{4/3}$ behavior observed for π^+ diffractive dissociation into $\pi^+\pi^+\pi^-$ systems,[3] and the falloff in t is consistent with the functional form $f(A^{-2/3}t)$, expected from simple optical models and observed in π^+ dissociation.[3]

The A dependence of the integrated coherent cross section for $K^+\omega$ masses below 1.5 GeV and $t < t^*$ is displayed in Fig. 4. (The error bars contain statistical and target-dependent uncertainties added in quadrature.) Shown for comparison is the dependence obtained for π^+ dissociation into low-mass 3π systems at the same beam energy (the relative normalization of the K^+ and π^+ results is arbitrary).

We conclude that the A dependence of K^+ coherent dissociation into $K^+\omega$ low-mass systems is consistent with that observed for π^+ dissociation into $\pi^+\pi^+\pi^-$ systems.

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