Investigation of the $a_0^+(980)$ Resonance in the Reaction $pp \to dK^+\bar{K}^0$ with ANKE*

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The production of the light scalar resonances $a_0(980)$ and $f_0(980)$ in hadronic interactions is under investigation at the ANKE spectrometer, where their strange decays into $K\bar{K}$ can be observed. Final goal of these studies, which will be later supplemented by measurements of the non-strange decays with the WASA detector, is to learn about the nature of these states, about isospin violating processes in the a_0/f_0 system and FSI effects between antikaons and light nuclei.

The first two experiments on $a_0^+(980)$ production (where contributions of the $f_0(980)$ must be absent) have been performed in pp collisions at $T_p = 2.65$ GeV (2001) [1] and $T_p = 2.83$ GeV (2002). Events of the type $pp \to dK^+X$ have been measured at ANKE, identifying the $\bar{K}^0$ by a missing-mass criterion. Contaminations from misidentified events are smaller than 10%.

Due to a large number of zero elements in the acceptance matrices [2] for the higher beam energy, it is impossible to follow the model independent acceptance correction procedure which has been used for the $T_p = 2.65$ GeV data [1].

However, in the close-to-threshold regime only a limited number of final states can contribute. Thus, for the data analysis we have restricted ourselves to the lowest allowed partial waves, *i.e.* s-wave in the $K\bar{K}$ system accompanied by a p-wave of the deuteron with respect to the meson pair ($a_0^+(980)$-channel) and p-wave $K\bar{K}$ production with an s-wave deuteron (non-resonant prod.) [1]. With this assumption the data at $T_p = 2.65$ GeV are well explained. The square of the transition matrix element can then be written as

$$|\bar{\mathcal{M}}|^2 = C_0^q q^2 + C_0^k k^2 + C_1(\hat{p}\cdot\vec{k})^2 + C_2(\hat{p}\cdot\vec{q})^2 + \\ + C_3(\vec{k}\cdot\vec{q}) + C_4(\hat{p}\cdot\vec{k})(\hat{p}\cdot\vec{q}) \,. \qquad (1)$$

Here $\vec{k}$ is deuteron momentum in the overall CMS, $\vec{q}$ denotes the momentum of the K^+ in the $K\bar{K}$ system, and $\hat{p}$ is the unit vector parallel to the beam direction. Only $K\bar{K}$ p-waves contribute to C_0^q and C_2, only $K\bar{K}$ s-waves contribute to C_0^k and C_1, and only $s\cdot p$ interference terms to C_3 and C_4. In order to determine the coefficients C_i, fits of the uncorrected (to acceptance) distributions have been made using GEANT simulated data samples, varying C_i. The best fit results are displayed in Fig. 1 for two measured invariant-mass and four angular distributions. The fit reveals dominance of $K\bar{K}$ s-wave production (*i.e.* the $a_0^+(980)$-channel) for both beam energies, see Table 1.

Table 1: Quality and results of the fit.

T_p	2.65 GeV	2.83 GeV
χ^2/ndf	1.4	1.1
$K\bar{K}$ s-wave	95%	88%
$K\bar{K}$ p-wave	5%	12%

The results for the data at $T_p = 2.65$ GeV are consistent with the published data where a different method of acceptance correction has been applied.

Having determined the coefficients C_i one can simulate differential distributions at the target, track the events through the ANKE setup and, thus, determine the differential acceptances as a function of the kinematical variables displayed in Fig. 1. Knowing these acceptances, differential cross sections can be extracted from the data which are shown in Fig. 2.

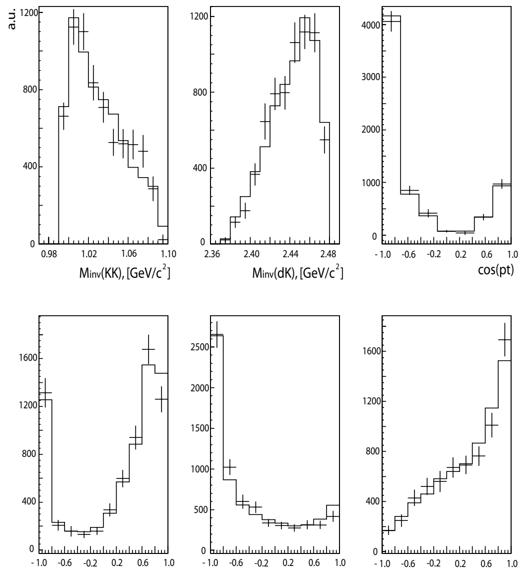

Fig. 1: Best fit of acceptance uncorrected data at $T_p = 2.83$ GeV. Cos(pt) is the angle between the K^+ momentum, measured in the CMS, and the beam proton; all other angles are described in the text.

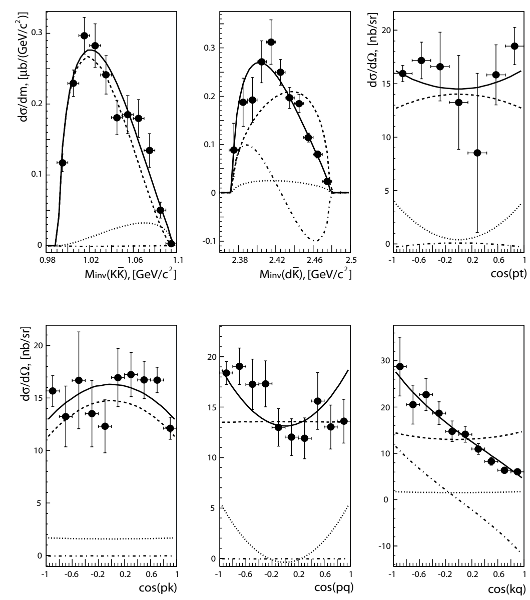

Fig. 2: Angular and invariant mass distributions for $T_p = 2.83$ GeV. The dashed (dotted) line corresponds to $K\bar{K}$ production in a relative s- (p-)wave, the dash-dotted to the interference term and solid line is the sum of them.

References:

[1] V.Kleber et al., Phys. Rev. Lett., **91**, 172304 (2003)
[2] M.Büscher et al., IKP Annual Report 2004.

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