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

V. Kleber, M. Büscher, P. Fedorets, C. Hanhart, V. Koptev

A main goal of the scientific program at ANKE is the investigation of the light scalar resonances $a_0(980)/f_0(980)$ in pp, pn, pd and dd collisions near the $K\overline{K}$ threshold. The first two experiments have been performed in pp collisions in the beginning of 2001 at $T_p = 2.65$ GeV ($Q = 46$ MeV) and in the beginning of 2002 at $T_p = 2.83$ GeV ($Q = 103$ MeV). Both measurements aim at the investigation of the reactions $pp \to da_o^+ \to d\pi^+\eta/dK^+\overline{K^0}$ by detecting coincident $d\pi^+/dK^+$ pairs and studying events with a missing $\eta/\overline{K^0}$. The preliminary results of the analysis of $dK^+\overline{K^0}$ events at $T_p = 2.65$ GeV is presented here. The procedure of identifying these events has been described in Ref. [1]. About 1000 events survive the selection chain and have been corrected for efficiency and acceptance. These events correspond to a total cross section of $\sigma_{tot} = (38 \pm 2 \pm 14)$ nb for the reaction $pp \to dK^+\overline{K^0}$ which is very close to the value predicted in Ref. [2].

The geometrical acceptance of ANKE has been determined as a function of four independent variables, the two invariant squared masses $m^2(K^+\overline{K^0})$ and $m^2(d\overline{K^0})$ and two Euler angles. The efficiency and acceptance corrected invariant masses $m(K^+\overline{K^0})$ and $m(d\overline{K^0})$ are shown in Fig. 1. The mass

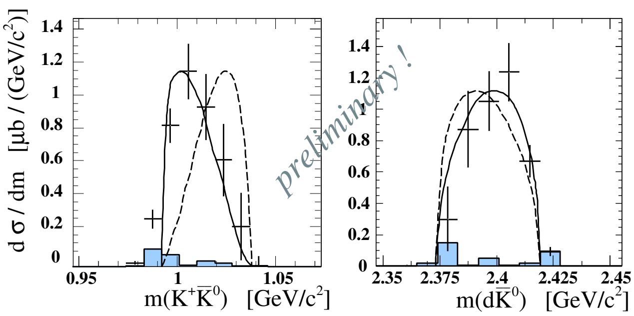

Fig. 1: Mass distributions of $pp \to dK^+\overline{K}^0$ events. The error bars represent the statistical uncertainty whereas the shaded distribution reflects the systematic uncertainty imposed by the procedure of acceptance correction.The curves are taken from Ref. [3] (see text).

distribution $m(K^+\overline{K^0})$ is limited by the $K\overline{K}$ threshold at low masses and by the COSY beam energy of $T_p = 2.65$ GeV at high masses. The mass distribution $m(K^+\overline{K^0})$ has been calculated in a simple phase space approach where the deuteron is in an P-wave (S-wave) and the two kaons in a relative S-wave (P-wave) [3]. The corresponding distribution is represented by the solid (dashed) curve in Fig. 1, left side. $dK^+\overline{K^0}$ events in an overall relative S-wave are forbidden due to angular momentum and parity conservation. The experimental data seem to favor events with zero angular momentum in the $K^+\overline{K^0}$ system (low relative energy) suggesting that a significant part of the $K^+\overline{K^0}$ pairs is produced via the $a_0^+(980)$ resonance.

The experimental invariant mass distribution $m(d\overline{K^0})$ is shown in Fig. 1, right side. The corresponding distributions with a P-wave (S-wave) deuteron is represented by the solid (dashed) curve. As for the invariant mass $m(K^+\overline{K^0})$ the experimental data seem to favor events with a P-wave deuteron and the $K^+\overline{K^0}$ system in a relative S-wave.

Three angular distributions have been determined and are shown in Fig. 2. The notation is described in Fig. 2a. p and k are the cm-momenta of the beam proton and the deuteron, respectively, and q is the relative cm-momentum of the two kaons. Assuming that only the lowest partial waves (S/P) are contributing, the angular distributions have been calculated model independently, resulting in second order polynomials for Fig. 2b and c and a first order polynomial for d. The experimental data have been fitted by these functions and are shown with their χ^2 per degree of freedom. The dashed lines in Fig. 2c and d represent the angular distributions for the assumption that all $K^+\overline{K^0}$ pairs have been produced via the $a_0^+(980)$ resonance only. This assumption seems to contradict the experimental distributions, which rather suggest that there is a second contribution. As suggested in Ref. [4] this could be the FSI between the $d\overline{K^0}$ pair mediated by the $\Lambda(1405)$.

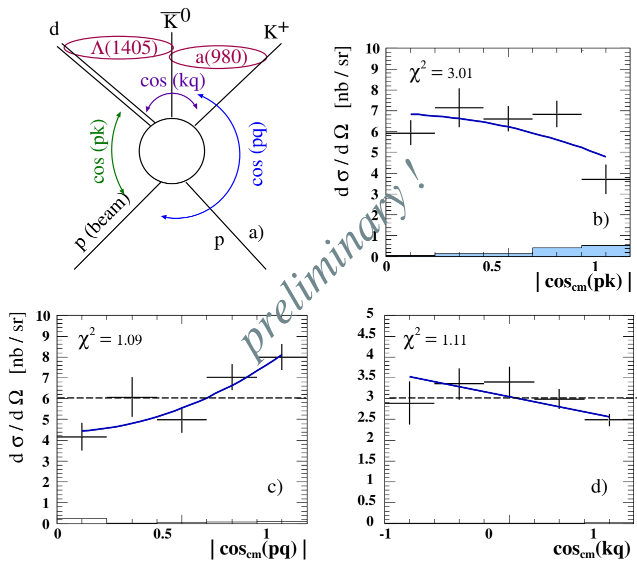

Fig. 2: Angular distributions of $pp \to dK^+\overline{K}^0$ events. The conventions for the uncertainties is the same as in Fig. 1. The data have been fitted for the assumption that only S- and P-waves are contributing. The dashed line reflects the distributions if all $K^+\overline{K^0}$ pairs were a_o^+ decay products which seems to contradict the experimental distributions.

References:

[1] V. Kleber *et al.*, IKP Annual Report 2001
[2] V. Grishina *et al.*, contribution to this annual report
[3] V. Chernyshev *et al.*, nucl-th/0110069 (2002)
[4] E. Oset *et al.*, Eur. Phys. J. **A 12** (2001) 435