Investigation of the $a_0^+(980)$ Resonance at ANKE

V. Kleber, M. Büscher, P. Fedorets, V. Koptev, M. Nekipelov

In a recent ANKE beam time (Jan./Febr. 2001) a first experiment on the production of scalar mesons in pp collisions was performed. The goal of this experiment is to investigate the charged $a_0(980)$ resonance, a candidate for the scalar meson nonet, in the reaction $pp \to da_0^+$.
The $a_0(980)$ is known to decay in $K\overline{K}$, $\pi\eta$ and 2γ [1]. At ANKE the deuteron in coincidence with the decay K^+ or π^+ can be detected. Kaons and pions are identified by the side detection system (SD) [2] via their TOF and energy loss. The TOF between the start and stop counters is shown in Fig. 1, left side. The fast pions cause the left peak, protons the right. To select pions it is sufficient to cut on their TOF. Cutting on energy loss in the ΔE counter reveals a kaon peak on a background distribution between the pion and proton peaks (small figure). This background is almost completely suppressed by requiring a coincident deuteron in the forward detection system (FD). These deuterons are distinguished from other fast particles by their TOF relative to a pion or kaon in the SD. The TOF of forward particles relative to pions detected in the sidewall counters is shown in figure 1, right side. Two bands from protons and deuterons are seen. Cutting along the deuteron band allows to investigate the a_0^+ with a missing mass analysis.

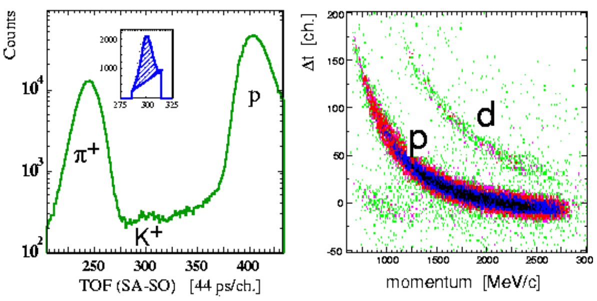

Fig. 1: Identification of particles in the SD and FD of ANKE.

If a deuteron and a K^+ are detected from pp collisions at T=2.65 GeV the missing particle must be a $\overline{K}^0$ due to energy and strangeness conservation. In fact the missing mass distribution $m(pp,dK^+)$ of the coincident dK^+ events (see Fig. 2, left side) shows a clear peak around the $\overline{K}$ mass containing about 600 events. There is only very little background from misidentified particles ($<$3%).

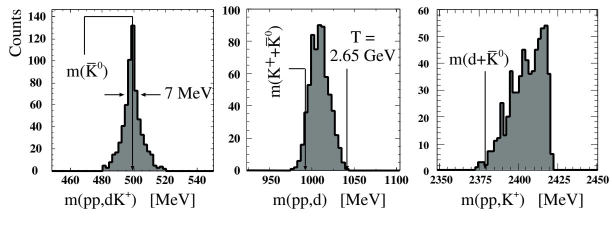

Fig. 2: Missing mass distributions of $pp \to dK^+\overline{K}^0$ events.

In the missing mass distribution $m(pp,d)$ the a_0^+ should be seen (see Fig.2, middle). However, the available phase space is limited by the $K^+\overline{K}^0$ threshold ($m_{\rm min}$=991 MeV) and the COSY beam energy T=2.65 GeV ($m_{\rm max}$=1038 MeV). Therefore one can hardly distinguish whether the $K^+\overline{K}^0$ events stem from an a_0^+ decay or from non resonant production. In any case the missing mass distribution would look similar.
The $dK^+\overline{K}^0$ events though offer the possibility to investigate the $d\overline{K}$ FSI which is supposed to be strong [3]. The corresponding missing mass distribution $m(pp,K^+)$ is shown in figure 2 (right side). All mass distributions are not yet corrected for detection efficiencies and acceptances. It is assumed that both corrections do not have a strong influence on the distributions except for $m(pp,K^+)$.
The observed 600 $dK^+\overline{K}^0$ events correspond to a total cross section of $\sim$40 nb. This value is still preliminary due to the ongoing analysis.
For events with a coincident deuteron-pion pair the missing mass distribution $m(pp,d\pi^+)$ shows a huge background distribution increasing with the mass (Fig.3, left side). At 550 MeV a peak is visible stemming from $d\pi^+\eta$ events. The peak contains about 2300 η mesons and has a width of $\sim$16 MeV. In the missing mass distribution $m(pp,d)$ a shoulder at the mass of the a_0^+ a background distribution is seen (Fig.3, right side). Assuming that background events left and right to the η peak have the same behavior as the background below the peak this background is subtracted. In the missing mass histogram $m(pp,d)$ only the shaded events survive with a peak at the a_0^+ mass and a width of about 40 MeV.
The result of this experiment will be determination of the total cross sections of the reactions $pp \to dK^+\overline{K}^0$ and $pp \to da_0^+ \to d\pi^+\eta$ at T=2.65 GeV. In February 2002 a second beam time on a_0^+ production will be performed at 2 or 3 higher beam energies [4]. Higher beam energies correspond to wider missing mass intervals which seem to be essential to determine the ratio of resonant and non resonant $K^+\overline{K}^0$ pair production. Moreover we hope to be able to determine the a_0^+ width, the ratio of $a_0^+ \to K^+\overline{K}^0$ and $a_0^+ \to \pi^+\eta$ decays and to draw conclusions on the d$\overline{K}$ FSI.

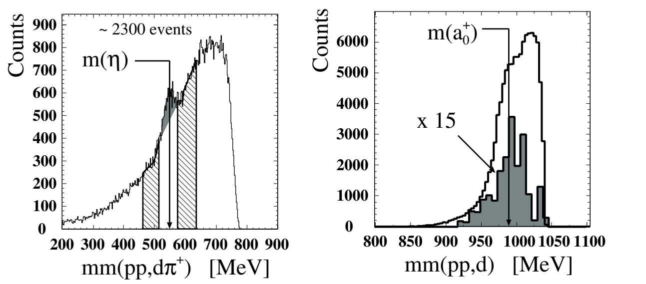

Fig. 3: Missing mass distributions of $pp \to d\pi^+X$ events.

References:

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[2] M.Büscher et al., contribution to this Annual Report
[3] E. Oset et al., nucl-th/0109050.
[4] M. Büscher et al., Beam time request for COSY proposal #55, 2001; available via http://ikpd15.ikp.kfa-juelich.de:8085/doc/Proposals.html.