Hyperon Production at ANKE

V. Koptev[a], I. Zychor[b], P.Kravchenko[a] and M.Nekipelov[a]

The production and properties of hyperons have been studied for more than 50 years, mostly in pion and kaon induced reactions. Hyperon production in *pp* collisions close to the threshold has been studied at SATURNE (Saclay, France) and COSY-Jülich. At COSY beam energies only six hyperons can be produced: $\Lambda(1116)$, $\Sigma(1192)$, $\Sigma(1385)$, $\Lambda(1405)$, $\Sigma(1480)$ and $\Lambda(1520)$. Reasonably complete information on $\Lambda(1116)$, $\Sigma(1192)$, $\Sigma(1385)$ and $\Lambda(1520)$ hyperon-production cross sections and their characteristics, found in the literature, are used for the normalisation of our data.

For the $\Lambda(1405)$, in spite of rather high statistics achieved (the total world statistics is several thousand events), there are still open questions concerning the nature of this resonance: is it a singlet *qqq* state in the frame of SU(3) or a quark-gluon *(uds-q)* hybrid, or a KN bound state? Thus more detailed studies of different decay modes of the $\Lambda(1405)$ are needed for a better understanding of its nature.

The $\Sigma(1480)$ hyperon is not well established yet. In the 2002 Review of Particle Physics it is described as a 'bump' with unknown quantum numbers. The branching ratios for possible decay modes $(N\overline{K}, \Lambda\pi, \Sigma\pi)$ are known with errors between 60 and 70 %. The total world statistics for this 'bump' is less than two hundred events.

Both the $\Lambda(1405)$ and the $\Sigma(1480)$ were produced mainly from decays of heavier hyperons in kaon and pion induced reactions. At COSY they are produced directly in $pp{\to}K^+pY^*$ reactions. It is essential that the ANKE spectrometer permits the simultaneous observation of different decay modes: $Y^*{\to}\pi^+\Sigma^-$, $Y^*{\to}\pi^-\Sigma^+$ and $Y^*{\to}K^-p$. To realize this project it is necessary to analyse triple coincidences: positively and negatively charged particles detected by the three different parts of the ANKE detector system (side, forward and negative).

The first measurement of *pp* interactions using a cluster-jet hydrogen target, carried out in spring 2002, demonstrated the feasibility of these studies at ANKE. A missing mass spectrum in the reaction $pp \to K^+pM_X$, resulting from detection of the 2-fold K^+p coincidences at proton beam energy $T_p = 2.83\,\text{GeV}$, is shown in Fig. 1a). Different hyperons ($\Lambda(1116)$, $\Sigma(1192)$, $\Sigma^*(1385)$, $\Lambda^*(1405)$, $\Sigma^*(1480)$) and hyperons with additional pions ($\Lambda\pi$, $\Sigma\pi$, $\Sigma\pi\pi$) can be identified in this spectrum. From phase space simulations and after fitting to ex-

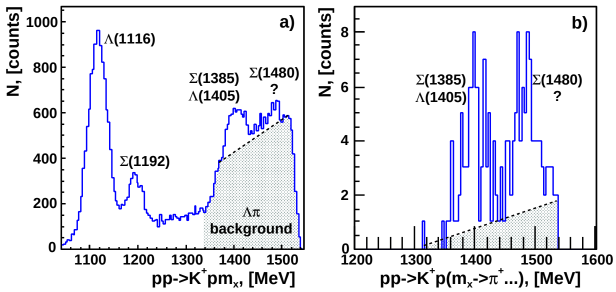

Fig. 1: Missing mass spectra obtained for the reaction 2.83 GeV $pp \to K^+pM_X$

perimental spectra the following relations of cross sections of the indicated processes were obtained: $1 : 0.16 : 0.03 : 0.025 : 0.005 : 0.12 : 0.002 : 0.002$. A shaded area in Fig. 1a) corresponds to the sum of processes with production of the additional pion.

The 3-fold $K^+p\pi^+$ coincidences were selected to study heavier hyperons Y^* ($\Sigma^*(1385)$, $\Lambda^*(1405)$, $\Sigma^*(1480)$). A missing mass spectrum in the reaction $pp \to K^+p\pi^+M_X$ consists of a flat plateau with a peak at approximately 1195 MeV. The peak corresponds to the decay $Y^* \to \pi^+\Sigma^-$. If only events with $M_X = (1195 \pm 20)\,\text{MeV}$ are selected, then the m_x spectrum in the reaction $pp \to K^+p\,(m_x = \pi^+ + M_X)$ shows two peaks with a width of 45 MeV each (see Fig. 1b)). One of them corresponds to the contribution of $\Sigma(1385)$ and $\Lambda(1405)$ hyperons with a ratio of $1 : 3$ under the peak taking into account the relation of the cross sections indicated above. The second peak can be ascribed to the production of the $\Sigma(1480)$. In order to prove this a similar analysis of 3-fold $K^+p\pi^-$ coincidences is necessary as well as the selection of the events corresponding to the decay $Y^* \to \pi^-\Sigma^+$. During a subsequent beam time in spring 2002 a detector for negatively charged particles was operating and the analysis of $K^+p\pi^-$ events is in progress.

[a] Petersburg Nuclear Physics Institute, Gatchina, Russia
[b] The Andrzej Sołtan Institute for Nuclear Studies, Świerk, Poland