First Results on K^+ Production in pD Interactions from ANKE

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Experimental data on the K^+-production cross section from pn interactions in the close-to-threshold regime are not available yet. This quantity is, for example, crucial for the theoretical description of pA and AA data since it has to be used as an input parameter for corresponding model calculations, like transport codes see, e.g. Ref. [1]. Predictions for the ratio σ_n/σ_p range from one to six, depending on the underlying model assumptions: in Ref. [2] it has been proposed that there is no difference between K^+ production on neutron and proton, whereas the analysis in Ref. [3] yields $\sigma_n/\sigma_p \sim 2$ for the total production cross sections. The authors of Ref. [4] draw an analogy between K^+- and η-meson production and give even higher value six for the σ_n/σ_p.

K^+-production in pn interactions has been investigated with ANKE at two beam energies, $T_p = 1.83$ and 2.02 GeV. Because of the impossibility to build neutron target a cluster deuterium target has been used as quasi-free neutron target.

Figure 1 shows the K^+-momentum spectrum for both beam energy. Based on the assumption that the K^+-production cross section is governed by the sum of the elementary pp and pn cross sections, the spectra have been analyzed in a simple phase-space approach, assuming $\sigma_{\mathrm{D}} = \sigma_p + \sigma_n$ with σ_n/σ_p being a free parameter. The main results of this analysis are described below, however, for further details we refer to a forthcoming publication.

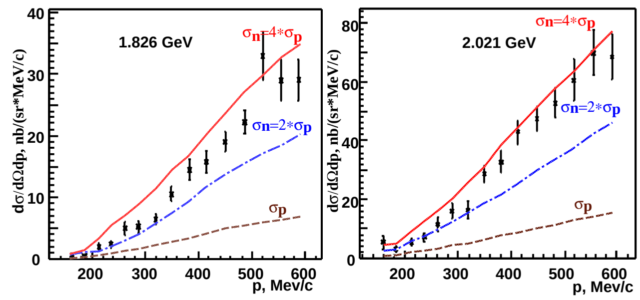

Fig. 1: Double differential $p\mathrm{D} \to K^+X$ cross section at 1.83 and 2.02 GeV in comparison with our phase-space calculations using different values for ratios σ_n/σ_p (lines). The vertical and horizontal kaon emission angles have been restricted to $\vartheta < 4°$ during the analysis. The overall systematic uncertainty from the luminosity normalization of 20% is not included in the error bars.

In order to determine σ_n/σ_p, phase-space distributed $pp \to K^+X$ and $pn \to K^+X$ events have been generated with a PLUTO package [5] taking into account intrinsic motion of the nucleons in a deuteron. The events have been generated for all reaction channels which may lead to K^+-production in pN interactions at our beam energy, and have been weighted according to the cross-section given by parameterization from Ref. [3]. Each event has been subsequently tracked through the spectrometer, and all detection efficiencies have been taken into account. In Fig. 1 we show the resulting momentum spectra based on the approach from Ref. [2] (the dashed line labeled "σ_n=σ_p") and Ref. [3] (the dash-dotted line labeled "σ_n=$2\sigma_p$").

The apparent difference between the calculated and measured cross sections can be due to the fact that the ratio σ_n/σ_p is different than in Refs. [2, 3]. Thus we repeated the simulations keeping the relative weights of the individual pp and pn channels constant (as given by Ref. [3]) but treating the ratio of the sum of these two contributions, i.e. σ_n/σ_p, as a free parameter. The best agreement between data and calculations is obtained for $\sigma_n/\sigma_p \sim 3$ at 1.83 GeV and $\sigma_n/\sigma_p \sim 4$ at 2.02 GeV (solids lines in Fig. 1).

The resulting large cross-section ratio σ_n/σ_p from the inclusive spectra is supported by the analysis of missing-mass spectra from $p\mathrm{N} \to K^+pX$ events recorded during the same beam time. The spectrum measured at $T = 2.02$ GeV shown in Fig. 2 is compared with the result of Monte-Carlo simulations, again for different ratios σ_n/σ_p. In the simulations it has been taken into account that protons can either stem from the K^+ production processes (e.g. $pp \to pK^+\Lambda$ but not from $pn \to nK^+\Lambda$) or from the subsequent hyperon decay (pp and pn). The best agreement between data and simulations is obtained with $\sigma_n/\sigma_p \sim (4-5)$.

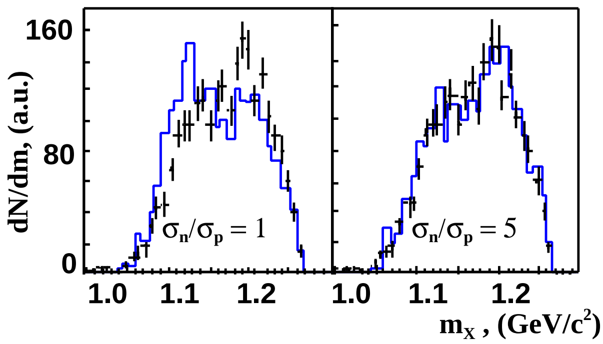

Fig. 2: Missing mass m_X for $p\mathrm{N} \to K^+pX$ events at $T = 2.02$ GeV in comparison with our phase-space calculations using different ratios σ_n/σ_p (lines).

References:

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