Study of the low energy dynamics in the ppK^+K^- system using the COSY-11 detection setup

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The near threshold production of K^+K^- pairs in proton-proton collisions has been investigated at ANKE and COSY-11 below and above the threshold for the ϕ meson production [1, 2, 3, 4, 5]. The excitation function determined for the $pp \to ppK^+K^-$ reaction cannot be described by a phase-space distribution including proton-proton final state interaction. The discrepancy may be assigned to the influence of K^+K^- or pK^- interaction. Indeed, as shown by the authors of reference [4, 5] the inclusion of the pK^-–FSI reproduces the experimental data for the excess energies down to the point at Q = 28 MeV. However, the inclusion of pp and pK^- final state interaction is still not sufficient to describe the data very close to threshold. This discrepancy may be due to the influence of the K^+K^- interaction, which was neglected in the calculations.

The authors of reference [4] pointed out that the enhancement of the total cross section near threshold may, at least partially, be due to the neglect of the pK^-–FSI in the calculations of the COSY-11 acceptance. As a consequence the obtained total cross sections might decrease, if the interaction would have been taken into account during the analysis of the experimental data. This suggestion encouraged us to check quantitatively the influence of the interaction in the pK^- subsystem on the acceptance of the detection setup. To this end we derived the distributions of the differential cross section for data at excess energies of Q = 10 MeV and Q = 28 MeV for two different assumptions. First we assumed that the acceptance depends only on the pp–FSI, then we included in addition the pK^-–FSI and derived analogous distributions. The resulting differential cross sections, which can be found in reference [6], show that the acceptance of the COSY-11 detection setup is only very weakly sensitive to the interaction between K^- and protons.

The derived distributions of the absolute values for the differential cross section constitute an additional information to the total cross sections published previously in reference [3]. In the article [3] the values of the cross sections were determined using the total number of events identified as the $pp \to ppK^+K^-$ reaction and the total acceptance of COSY-11. Now after the determination of the absolute values for the differential distributions one can calculate the total cross sections in the less model dependent manner, regardless of the assumption of the pp–FSI. The cross sections calculated for both excess energies resulting from the following integral:

$$\sigma_{tot} = \int \frac{d\sigma}{dM_{pp}} dM_{pp} ,$$

amount to $\sigma_{tot} = (0.95 \pm 0.17)$ nb for measurement at $Q = 10$ MeV and $\sigma_{tot} = (6.5 \pm 1.1)$ nb for $Q = 28$ MeV. These results are even larger than the previously obtained total cross sections by about 20 % for the lower excess energy and 50 % for Q = 28 MeV, which strengthen the confidence to the observed enhancement close to threshold. However, the total cross sections obtained in these two different analyses are statistically consistent.

The determination of the absolute values for the differential cross sections permitted us to establish the absolute values

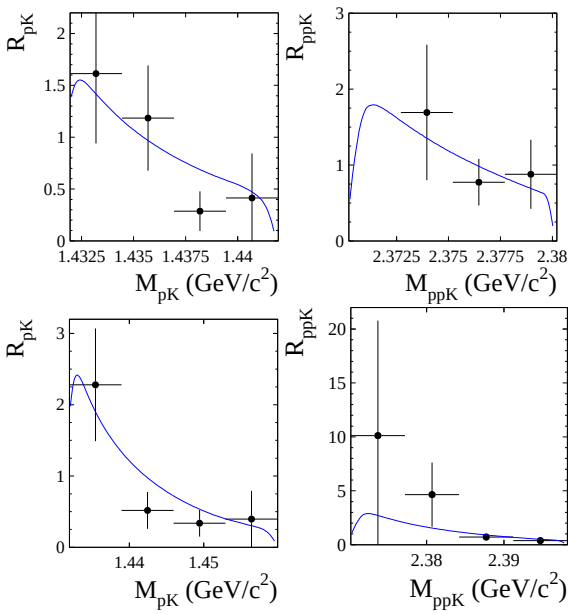

Fig. 1: The distributions of the ratios R_{pK} and R_{ppK} for data at Q = 10 MeV (upper panel) and Q = 28 MeV (lower panel). Solid curves represent calculations taking into account pp and pK^- final state interaction.

for the following ratios at the close to threshold region:

$$R_{pK} = \frac{d\sigma/dM_{pK^-}}{d\sigma/dM_{pK^+}} , \qquad R_{ppK} = \frac{d\sigma/dM_{ppK^-}}{d\sigma/dM_{ppK^+}} .$$

In the presence of the pp–FSI only, the distribution of R_{pK} as well as R_{ppK} should be flat and equal to unity. But as one can see in Fig. 1, and as presented already in the previous publication, by COSY-11 [3] and ANKE [4] R_{pK} for both excess energies is far from constant and increases towards the lower M_{pK} invariant masses. This effect might be connected with the influence of the pK^- final state interaction. Similarly the distributions of R_{ppK} differs from expectations assuming only interaction in the pp system. It is important to note that the determined absolute ratios of cross sections are satisfactory well described using the parametrisation introduced in article [4] and the values of the a_{K^-p} extracted from the ANKE data at higher excess energies [4].

References:

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