

Several recent experiments have reported evidence for a narrow resonance Θ^+ , with strangeness $S = +1$ [1, 2]. It was seen as a peak in the nK^+ invariant mass distribution at $1.54 \text{ GeV}/c^2$ with a width smaller than $25 \text{ MeV}/c^2$. The extracted mass and width are consistent with those of the pentaquark baryon Θ^+ consisting of $uudd\bar{s}$ quarks predicted in the chiral soliton model [3]. In the hitherto performed experiments hypothetical Θ^+ resonance was produced either in the electroweak interactions [1] or in the strong interaction between positively charged kaons and the nuclei [2]. Production of the Θ^+ in the elementary proton-proton interaction, might be investigated at COSY and in particular also at the COSY-11 facility. A signature of Θ^+ production may be the presence of a 1.54 GeV peak in the K^+n invariant-mass distribution for the $pp \rightarrow nK^+\Sigma^+$ reaction.

In order to study the production of Θ^+ , during the experiment performed in September 2003, an additional trigger enabling a simultaneous registration of kaons and neutrons had been arranged. Therefore, additionally to the planned studies of the $pp \rightarrow ppn'$ we registered on tapes also events corresponding to the $pp \rightarrow nK^+\Sigma^+$ reaction. Kaons were detected by means of the drift chambers and scintillator hodoscopes: Start and S1¹. Neutrons were registered in a special detector build out of slices of scintillator and lead pads². The identification of the short living Σ^+ hyperons is implemented via the missing mass technique, where the momenta of the kaons are reconstructed by tracking back their trajectories to the target point and the neutron's momentum is calculated from the time-of-flight measurement between target and neutron detector.

The data analysis aiming in the determination of the nK^+ invariant mass distribution has just started. Therefore in this report only the performed Monte Carlo simulations are presented.

In order to determine the COSY-11 detection system acceptance for the $pp \rightarrow nK^+\Sigma^+$ reaction we have simulated response of the detectors for $6 \cdot 10^7$ events generated in the target. The solid line in figure 1a shows the distribution of the K^+n invariant mass for the generated events, whereas the dashed histograms presents the spectrum which was reconstructed from the signals simulated in the detectors. The ratio of the obtained missing mass distributions results in the differential acceptance of COSY-11 for detecting the $pp \rightarrow nK^+\Sigma^+$ reaction as shown in figure 1b. Thus the overall integrated acceptance of our detection setup for the reaction $pp \rightarrow nK^+\Sigma^+$ at the beam momentum of $3.257 \text{ GeV}/c$, at which the measurement was performed, is equal to 10^{-4} .

Further the simulation of the invariant mass distribution of the process $pp \rightarrow \Sigma^+\Theta^+ \rightarrow \Sigma^+nK^+$ has been performed, taking into account the width of Θ^+ equal to 5 MeV [5]. Result of this simulations, is presented in

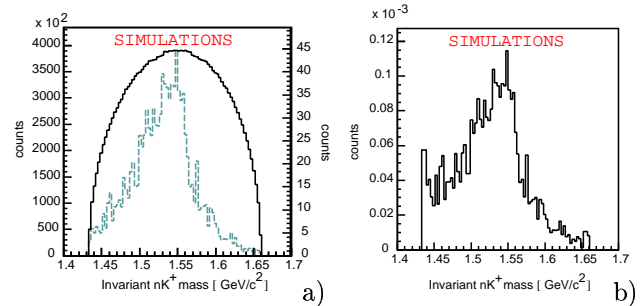


Fig. 1: (a) Phase space distribution of the invariant mass of nK^+ system of the $pp \rightarrow nK^+\Sigma^+$ reaction (solid line) and its convolution with the COSY-11 acceptance (dashed line). Note that the scale for the dashed histogram is on the right side of the figure. (b) The acceptance of COSY-11 detection setup for the $pp \rightarrow nK^+\Sigma^+$ reaction.

fig. 2a, and the expectations for the full invariant mass distribution of the nK^+ system are presented in figure 2b. Here we assume arbitrarily that the total cross section for the $pp \rightarrow \Sigma^+\Theta^+$ reaction is ten times smaller than the one for the $pp \rightarrow \Sigma^+nK^+$ reaction. If the performed assumptions were true, in the experiment we should observe a clear signal originating in the Θ^+ production as it is visible in figure 2b.

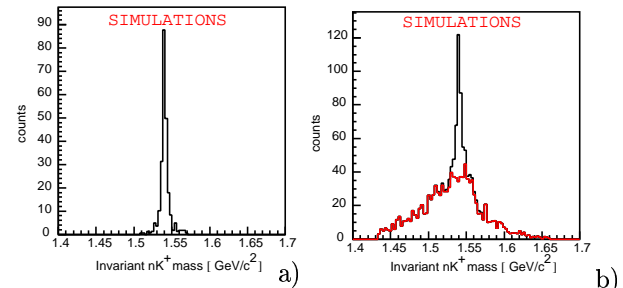


Fig. 2: (a) Invariant mass distribution of the nK^+ system as obtained in Monte-Carlo calculations for the $pp \rightarrow \Sigma^+\Theta^+ \rightarrow \Sigma^+nK^+$ reaction. (b) The expected signal from the $pp \rightarrow \Sigma^+\Theta^+$ together with the background from the direct $pp \rightarrow \Sigma^+nK^+$ reaction.

The analysis of the data from the September's run is proceeding and the preliminary results are expected in the next year.

References:

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- [2] V.V.Barmin et al, arXiv: hep-ex/0304040.
- [3] D.Diakonov, V.Petrov, and M.Poliakov, Z.Phys. A**359** (1997) 305.
- [4] P. Moskal et al., Ann. Rep. 1996, IKP FZ-Jülich, **Jül - 3365**, 35; R.Czyżykiewicz, Diploma Thesis, Jagellonian University (2002).
- [5] M.Poliakov, talk presented at CANU meeting, Bad Honnef (2003).

¹For the arrangement of the individual detectors in COSY-11 facility see for example the contribution of T. Rozek and D. Grzonka to this report.

²COSY-11 neutron detector structure is presented in [4]

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