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Threshold Hyperon Production at COSY-11

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The Λ, Σ^0 and Σ^+ hyperon production in NN collisions is studied at the COSY – 11 installation in order to investigate the production mechanism as well as to extract information about the Y-N interaction.

Keywords: hyperon production, Y-N interaction

COSY-11 is an internal magnetic spectrometer experiment at the COoler SYnchroton and storage ring COSY in Jülich. It is equipped with scintillator hodoscopes and drift chambers for charged particle detection [1] and a scintillator/lead sandwich detector for neutrons [2].

The Σ^0 and Λ hyperon production near the kinematical threshold was studied by the COSY-11 collaboration in $pp \rightarrow pK^+\Lambda/\Sigma^0$ reactions. Data points, 16 for the Λ and 13 for the Σ^0 channel, were taken in the excess energy range between 0.68 MeV and 59.3 MeV for the Λ hyperon and between 2.8 MeV and 59.1 MeV for Σ^0 [3,4,5]. The cross section ratio $\sigma(pp \rightarrow pK^+\Lambda)/\sigma(pp \rightarrow pK^+\Sigma^0)$ below excess energies of 15 MeV was measured to be around 28 in contrast to the value of about 2.5 determined for excess energies higher than $Q = 300$ MeV [6]. The ratio for higher energies is in good agreement with the Λ/Σ^0 isospin relation, which is 3 (see figure 1).

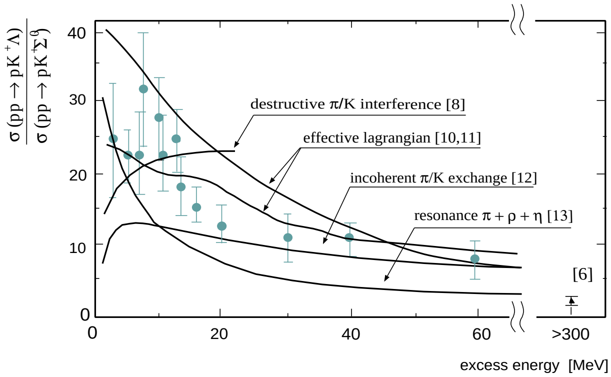

Fig. 1. Cross section ratio for Σ^0 and Λ production in the threshold region. The data are compared to different models descriptions.

To explain this unexpected threshold behaviour, various theoretical scenarios within meson exchange models were proposed. Calculations have been performed with pion and kaon exchange added coherently [8,9] or incoherently [12], including the excitation of nucleon resonances [10,13,11] and heavy meson exchange (ρ, ω and K^*) [10,11]. Although the various descriptions differ even in the dominant basic reaction mechanism, all more or less reproduce the trend of an increase in the cross section ratio in the threshold region. The present data are not sufficient to definitely exclude possible explanations. Further studies e.g. for the other isospin projections will help to understand the threshold hyperon production. To be more specific lets consider the Jülich meson exchange model[8,9] where calculations are available for other Σ channels. Within this model the large cross section ratio $\sigma(\Lambda)/\sigma(\Sigma^0)$ at threshold is reproduced by a destructive interference of π and K exchange amplitudes. Calculations of the Σ^+ production in this model predict a factor of three higher cross section compared to the Σ^0 channel for a destructive and a factor of three lower for a constructive interference, a clear experimentally accessible signal. The ratio between Σ^+ and Σ^0 production will also differ strongly if the dominant production mechanism runs via an intermediate N^* excitation or not.

Recently the Σ^+ production was measured at the COSY-11 installation via $pp \to nK^+\Sigma^+$ at Q = 13 MeV and Q = 60 MeV [7]. The Σ^+ is identified via the missing mass technique, by detecting the remaining reaction products - K^+ and neutron. The experimental resolution of the missing mass determination depends on the reconstruction accuracy of the four-momentum vectors for the registered neutrons and kaons. The momentum vector of the K^+ meson can be established by tracking the K^+ trajectory reconstructed from signals registered in the drift chambers (D1 and D2 in the figure 2) through the magnetic field back to the target point. Assuming a hit in the neutron detector being due to a neutron, the four-momentum vector of the neutron is given by the measured velocity, the direction

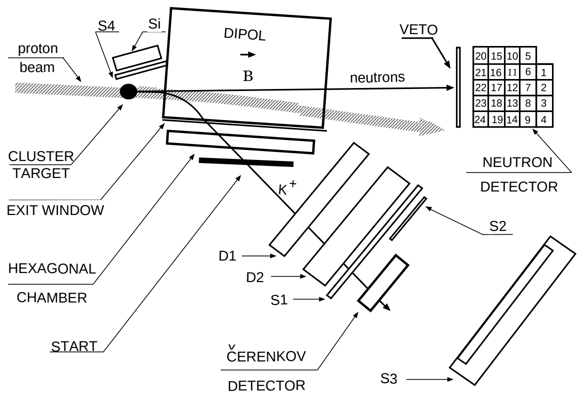

Fig. 2. COSY–11 detection setup with the superimposed tracks of kaon and neutron from the $pp \to nK^+\Sigma^+$ reaction.

(given by the first hit module) of the neutron which can be reconstructed with an accuracy of at least the size of the module (9x9 cm^2) and the known mass. The background from charged particles hitting the neutron detector is discriminated by veto scintillators (VETO in figure 2).
From the Monte Carlo studies the identification of the Σ^+ events is expected to be comparable to the Σ^0 or Λ channels[7]. The data are presently under analysis.

Acknowledgments

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