Spin-triplet final-state dominance in the pp → pnπ^+ reaction at 492 MeV

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Pion production in the $pp \to pn\pi^+$ reaction has been studied at ANKE by measuring the proton in the side wall and the pion in telescope #14 of the side detection system. By comparing results obtained with C and CH_2 targets, a clear neutron peak was seen with very little background.

The published results [1] shown in Fig. 1 were obtained using different angular cuts around the forward direction. The intrinsic resolution of our system for small np excitation energies E_{np} is about 160 keV but, because of limited statistics, this is worsened by summing over angular ranges.

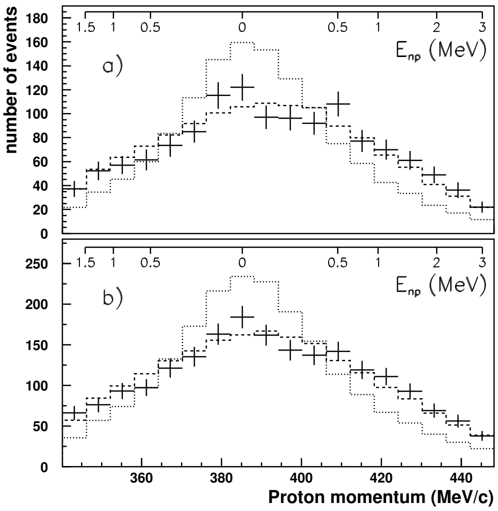

Fig. 1: Raw proton-momentum spectra of $pp \to pn\pi^+$ events (points with statistical errors), for events with $\theta_\pi \le 2°$. The relative np energy is indicated for protons and pions emitted at 0°. Figure a) is for $\theta_p \le 2°$ and b) for $\theta_p \le 2.5°$. The dashed histogram is a Monte Carlo simulation assuming pure spin-triplet final state. A statistical mixture of spin states, leads to the dotted histograms with χ^2/ndf =151.2/17 for a and χ^2/ndf =178.2/17 for b.

Data were obtained for $E_{np} \le 3$ MeV, which is the region where the spin-singlet and -triplet final-state-interactions give rise to strong peaking. Since the spin-singlet peak is much narrower (≈ 0.5 MeV) than the triplet (≈ 2 MeV), the *shape* of the spectrum is sensitive to the fraction of spin-singlet in the final state. After taking the angular averaging into account, the data in Fig. 1 are consistent with complete dominance by spin-triplet np final states with the singlet contributing at most 10%.

The same conclusion can be drawn from the *magnitude* of the cross sections shown in Fig. 2. The overall normalisations of these were obtained by measuring the $pp \to d\pi^+$ cross section in parallel. Here the deuteron was not detected but events were selected where there was no proton in the side detector. Using the Fäldt-Wilkin extrapolation theorem [2] it was possible to estimate the spin-triplet contribution to the $pp \to pn\pi^+$ cross section in terms of that for $pp \to d\pi^+$ in a largely model-independent way [3].

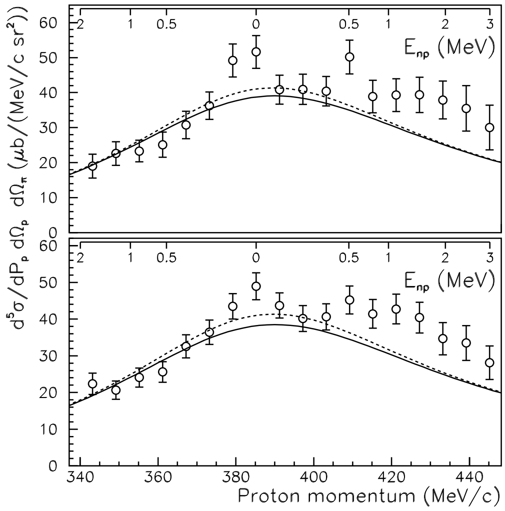

Fig. 2: Five-fold differential cross section for the $pp \to pn\pi^+$ reaction as a function of the measured proton momentum for events with $\theta_\pi \le 2°$. The np excitation energy is indicated for protons and pions emitted at 0°. Figure a) is for $\theta_p \le 2°$ and b) for $\theta_p \le 2.5°$. The solid (dashed) curves correspond to predictions for the spin-triplet contribution to the fsi peak after (before) averaging over the resolution. The estimates are expected to be only weakly model-dependent [3]

The good agreement to the data of Fig. 2 given by this approach is consistent with our claim that any singlet contribution to the cross section is at most 10% and probably much smaller.

The ANKE spectrometer is capable of simultaneously measuring fsi effects in $pp \to pn\pi^+$ and $pp \to pp\pi^0$ at different beam energies which would give even a more direct measure of the small spin-singlet contribution to the final state.

References:

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[2] G. Fäldt and C. Wilkin, Physica Scripta **56** (1997) 566.
[3] Yu.N. Uzikov and C. Wilkin, Phys. Lett. **B511** (2001) 191.

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