SPIN OBSERVABLES IN np ELASTIC SCATTERING AT PSI

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Two experiments, installed one behind the other, in the NA2 polarized neutron beam line at PSI have measured sixteen different two- and three-spin observables A_{oosk}, A_{ookk}, A_{oonn}, A_{ooss}, D_{onon}, D_{osok}, K_{osko}, K_{onno}, K_{osso}, N_{ossn}, N_{oskn} D_{osos}, N_{osns}, N_{onkk}, K_{okko} and K_{okso} between 260 and 535 MeV.

NN scattering is one of the basic reactions to study the nuclear force. We do not yet possess a satisfactory theory to describe it at all energies and angles. Asymptotic QCD is not valid here and one relies on phenomenological analyses such as phase shift analyses (PSA). The aim of the two experiments installed on the NA2 polarized neutron beam line was to study spin dependence in $\vec{n}\vec{p}$ elastic scattering at intermediate energies and enlarge the np data base. It is also intended to perform a direct reconstruction of the I = 0 complex amplitudes.

The PSI NA2 polarized neutron beam is created in the charge exchange reaction C($\vec{p}$,$\vec{n}$)X using 590 MeV longitudinally-polarized protons (typically 80% polarization) incident on a carbon target. It was found that the transfer of polarization was most efficient using longitudinally polarized protons. The generated neutron beam has a continuous energy spectrum, consisting of a quasielastic peak around 535 MeV and a broad continuum at lower energies [1]. The neutron beam polarization has a strong energy dependence [2]. The polarization of the neutrons can be rotated into vertical, longitudinal or sideways orientations. The proton polarization is flipped every second. An intensity of 5.10^5 $\vec{n}$/s.cm^2 at 14 m from the production target with 10 μA polarized protons is observed. The neutron energy is measured for each event by time-of-flight using the rf-signal from the accelerator operating in the 50 MHz mode.

The two experiments installed on the polarized neutron beam line, had the following properties: 1) Experiment I measured the $\vec{n}\vec{p}$ elastic reaction at large c.m. angle between 70° and 160° [3]. The 100 cm^3 polarized target, working in the frozen spin mode, was located at 13.7 m from the neutron production target. A relaxation time longer than 1000 hrs was achieved with polarization values between 60% and 80%. The scattered neutrons were detected in a hodoscope made of 11 plastic scintillation bars of 8x20x130 cm^3. The transverse polarization of the recoil proton was measured in a polarimeter made of carbon plates sandwiched between MWPCs. A hardware second level trigger, associated with the MWPCs, rejected unscattered events within 3 μsec.

2) Experiment II measured the $\vec{n}$p elastic reaction with a liquid hydrogen target located at 24 m from the neutron production target, at c.m. angles between 130° and 180°. A magnetic spectrometer analyzed the momentum of the recoiling protons. Behind the magnet, a polarimeter measured the transverse components of the spin. This experimental configuration allowed analyzis of the longitudinal components of the spin, since the horizontal components s and k were rotated in the vertical field of the magnet. Both the spectrometer and the polarimeter were equipped with drift chambers.

Results for some of the two-and three-spin dependent parameters are shown in fig. 1 at 535 MeV along with PSA predictions[4,5]. An accuracy of 0.12 has been reached for the 3-spin parameters, 0.08 for the spin-transfer parameters and 0.03-0.06 for the depolarization parameters. For the spin correlation parameters (not requiring a second rescattering on carbon to analyze the final proton polarization) the total errors (0.05) are dominated by systematics coming mainly from the knowledge of the target and the beam polarizations.

References

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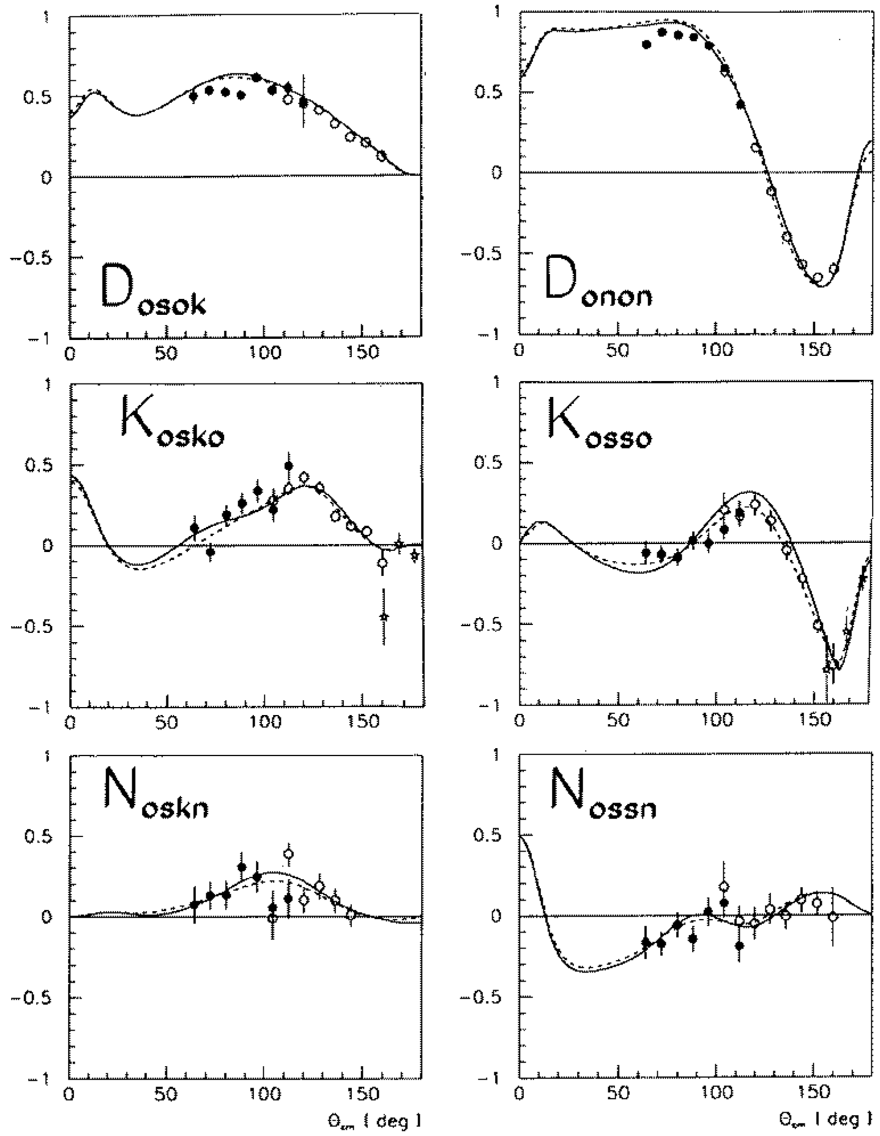

Figure 1: Some Two and three-spin dependent parameters at 535 MeV. The open and full circles are results from experiment I and stars from experiments II. The dashed and full line are predictions of VPI [4] and Saclay-Geneva [5] PSA respectively.