Measurement of the analysing power in proton-proton elastic scattering at small angles

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Motivation of the conducted experiments at ANKE-COSY [1] was absence of experimental data above 1 GeV at small angles (bellow 35^o). From other hand *NN* interaction, which is fundamental to the whole of nuclear physics, needs precise elastic scattering data as input to a phase–shift analysis ([2] PSA), from which the scattering amplitudes at fixed angles can then be reconstructed.

- The differential cross section for proton–proton elastic scattering has been measured at a beam kinetic energy of 1.0 GeV and in 200 MeV steps from 1.6 to 2.8 GeV for centre-of-mass angles in the range from 12◦–16◦to 25◦–30◦, depending on the energy. A precision in the overall normalisation of typically 3% was achieved by studying the energy losses of the circulating beam of the COSY storage ring as it passed repeatedly through the windowless hydrogen target of the ANKE magnetic spectrometer. It is shown that the data have a significant impact upon the results of a partial wave analysis. After extrapolating the differential cross sections to the forward direction, the results are broadly compatible with the predictions of forward dispersion relations.

- The proton analysing power in pp elastic scattering has been measured at small angles at COSY-ANKE at 796 MeV and five other beam energies between 1.6 and 2.4 GeV using a polarised proton beam. The asymmetries obtained by detecting the fast proton in the ANKE forward detector or the slow recoil proton in a silicon tracking telescope are completely consistent.

- The charge exchange of vector polarised deuterons on a polarised hydrogen target has been studied in a high statistics experiment at the COSY-ANKE facility at a deuteron beam energy of T_d=726MeV. By selecting two fast protons at low relative energy E_{pp}, the measured analysing powers and spin correlations are sensitive to interference terms between specific neutron–proton charge-exchange amplitudes at a neutron kinetic energy of $T_n \approx 1/2 T_d$=363MeV. An impulse approximation calculation, which takes into account corrections due to the angular distribution in the diproton, describes reasonably the dependence of the data on both E_{pp} and the momentum transfer. This lends broad support to the current neutron–proton partial wave solution that was used in the estimation.

- The vector and tensor analysing powers, A_y and A_{yy}, of the $pd \rightarrow n\{pp\}_s$ charge-exchange reaction have been measured at a beam energy of 600 MeV at the COSY-ANKE facility by using an unpolarised proton beam incident on an internal storage cell target filled with

polarised deuterium gas. The low energy recoiling protons were measured in a pair of silicon tracking telescopes placed on either side of the target. Putting a cut of 3 MeV on the diproton excitation energy ensured that the two protons were dominantly in the $^1S_0$ state, here denoted by $\{pp\}_s$. The polarisation of the deuterium gas was established through measurements in parallel of proton-deuteron elastic scattering. By analysing events where both protons entered the same telescope, the charge-exchange reaction was measured for momentum transfers $q > 160$ MeV/c. These data provide a good continuation of the earlier results at $q < 140$ MeV/c obtained with a polarised deuteron beam. They are also consistent with impulse approximation predictions with little sign evident for any modifications due to multiple scatterings. These successful results confirm that the ANKE deuteron charge-exchange programme can be extended to much higher energies with a polarised deuterium target than can be achieved with a polarised deuteron beam.

Literature:

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