MEASUREMENT OF SPIN ROTATION PARAMETERS A AND R IN $\pi^{\pm}p$ ELASTIC SCATTERING IN MOMENTUM RANGE 1.4–2.1 GeV/c

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Modern quark models of baryons predict differing spectra and characteristics of pion-nucleon resonances [1]. Comparison of these predictions with values extracted from experimental data by means of a partial-wave analysis (PWA) provides, in principle, a good possibility to choose the most realistic model. However, it appeares that the experimental database is not accurate enough for such comparison in the region of πN resonances with masses 1.9 to 2.2 GeV/c^2 (the second resonance region). Three PWAs existing in this region, KH [2], CMU-LBL [3] and VPI [4], result in different characteristics for many resonances. The main reason of such discrepancy is a lack of measurement of the spin rotation parameters A and R for elastic πp scattering in corresponding momentum range.

It can be shown that measurements of the parameters A and R are mostly important in some especial selected values of angle and momentum to exclude PWA ambiguities. After such measurements a new PWA will be performed in order to reconstruct unambiguously pion-nucleon scattering amplitude.

The objective of this experiment is to measure the spin rotation parameters A and R for πp elastic scattering in the momentum range 1.4 to 2.1 GeV/c where no such measurements were performed until now. The experimemt is carried out on a pion beam of the ITEP accelerator. Up to the end of 1993, a part of necessary statistics was obtained for $\pi^{+}p$ scattering at the momentum of 1.43 GeV/c, the covered angular range corresponded to 125°–140° in the centre of mass system.

Shown in Fig.1 are the predictions for the spin rotation parameter A^+ which were obtained using results of PWAs [2 - 4] for positive pions scattering angle $\Theta_{cm} = 135°$. The vertical dotted line corresponds to the momentum 1.43 GeV/c for which PWAs' predictions are very different: in conformity with PWA VPI [4] the parameter $A^+ = -0.6$, PWA CMU-LBL [3] predicts $A^+ = +0.4$ and PWA KH [2] results in $A^+ = +0.6$.

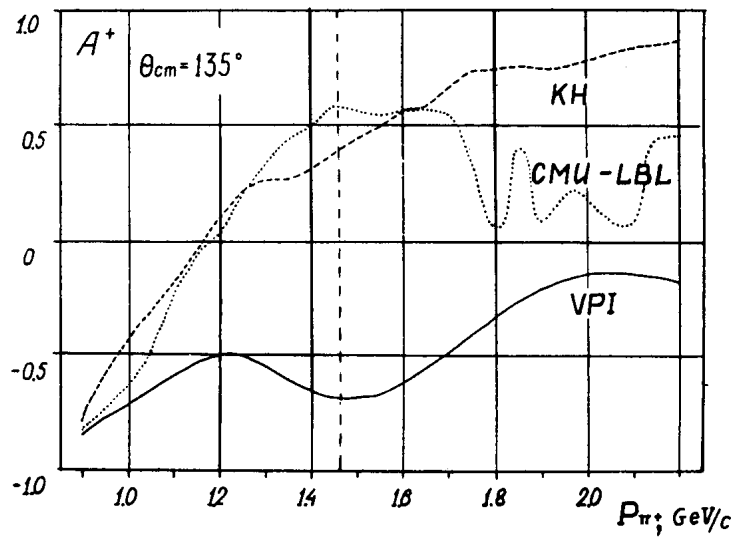

Fig.1. The predictions of the partial-wave analyses KH [2], CMU-LBL [3], VPI [4] for the spin rotation parameter A^+. The vertical dotted line corresponds to the momentum 1.43 GeV/c

The experimental setup is shown in Fig.2. The pion beam is incident on a proton polarized target [5]. The target consists of propanediol $C_3O_2H_8$ doped with Cr^v in the form of beads about 1.5 mm diameter. A refrigerator using ^3He evaporation provides a temperature of 0.6 K. A magnetic field of 2.5 T is produced by a pair of superconducting Helmholtz coils. The value of target polarization is typically 70–75%. The polarization vector lies in the horizontal plane and is parallel to the pion beam, this disposition corresponds to measuring the spin rotation parameter A.

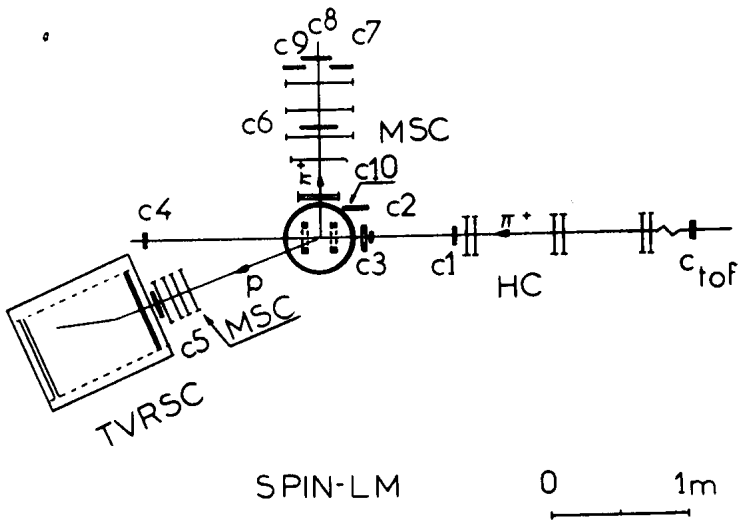

Fig.2. Experimental setup.
C1–C10, C_{tof} — scintillation counters; HC — hybrid chambers; MSC — magnetostrictive spark chambers; TVRSC — proton polarimeter including 20 gaps of optical spark chambers with television read-out

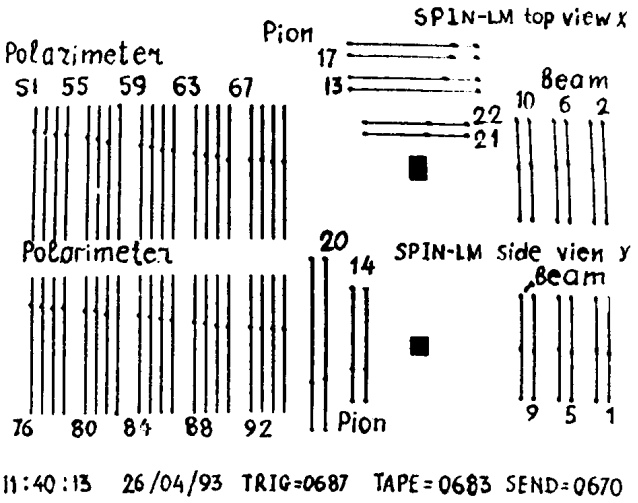

Fig.3. Display of track coordinates.
Top view scheme is presented in the upper part and side view scheme is presented in the lower part of the picture.

The pion beam track system involves scintillation counters, multiwire spark and hybrid chambers (HC). The scattered pions are detected by a set of eight magnetostrictive spark chambers (MSC) in the angular range 80°–100° in the lab.system. The horizontal (vertical) component of the polarization vector of the recoil protons is determined from measuring the vertical (horizontal) asymmetry of their secondary analyzing scattering on the carbon nuclei of a polarimeter. The polarimeter includes twenty gaps of optical spark chambers each having size 0.52 m×0.52 m, twelve of these chambers contain graphite electrodes. The total graphite thickness is about 61 g/cm^2, it corresponds to the length of pC-interaction for protons with 1 GeV energy. The spatial position of proton tracks is measured by means of a special television readout system with an accuracy ±0.5 mm. The polarimeter efficiency (i.e. the fraction of the recoil protons which experienced the analyzing scattering) was about 12%.

All information from the scintillation counters (C1-C10, C_{tof}) and track detectors (76 coordinates) is collected by electronics in the CAMAC standard and stored on magnetic tapes on-line with SM 1420 computer. The read-out system can read and process up to 10 events per second. The on-line program displays coordinates of tracks (see an example in Fig.3), trigger counts and a picture of spark chambers' performance. This program reconstructs events and creates histograms and plots which are necessary for equipment checking.

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