MEASUREMENT OF SPIN ROTATION PARAMETERS R AND A IN πp ELASTIC SCATTERING IN REGION OF LOW-LYING PION-NUCLEON RESONANCES

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Interest to the investigation of πp scattering in the resonance region has increased recently due to the development of various quark models predicting the spectrum of baryons. To choose the most realistic model one has to determine this spectrum from an experiment with high precision.

The investigation of pion-nucleon scattering provides, in principle, a good possibility to study excited states of nonstrange baryons (N- and Δ-resonances) by means of a phase-shift analysis of experimental data. Unfortunately, up to now characteristics of these resonances (and even the number of resonances) are known with insufficient accuracy and the main reason is the absence of spin-rotation data. To compensate the lack of these data, authors of phase-shift analyses have to impose additional strong theoretical constraints, the correctness of which is sometimes questionable. Only a direct measurement of the spin-rotation parameters can remove these problems and provide an unambiguous determination of the scattering amplitude and characteristics of the πN resonances.

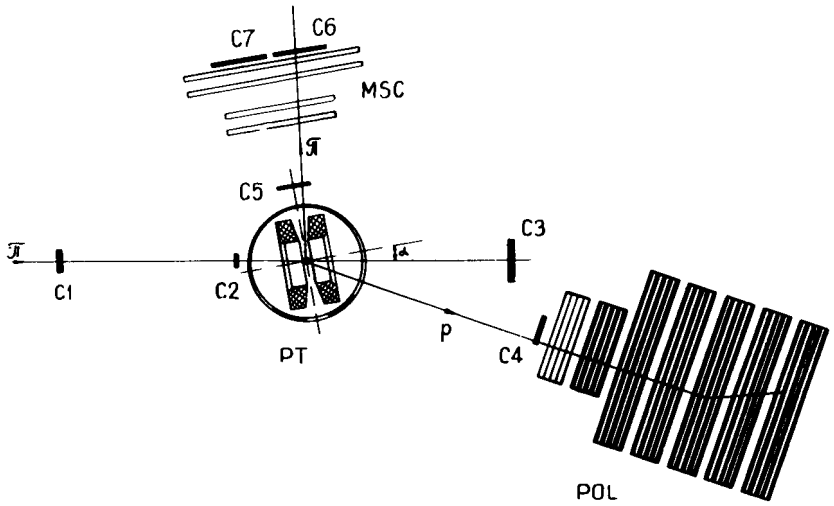

Fig. 1. Experimental layout. PT — polarized target; POL — polarimeter consisting of optical spark chambers with television read-out; MSC — wire spark chambers with magnetostrictive read-out; C1 ÷ C7 — scintillation counters

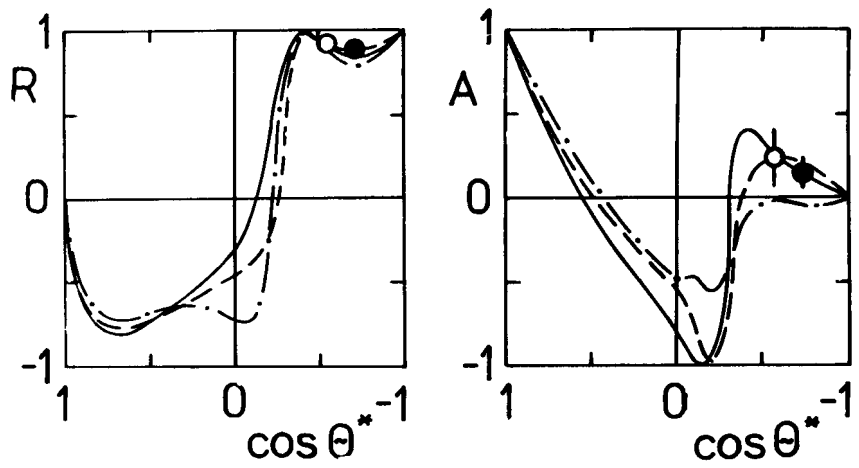

Fig. 2. Spin rotation parameters R and A in π^-p elastic scattering at $T_\pi = 560$ MeV measured at angle $\alpha = -35°$ (solid circles) and 10° (open circles). Shown by curves are predictions of partial wave analysis VPI [3] (solid curve), KH [4] (dashed curve) and CMU-LBL [5] (dash-dotted curve)

The experiment is carried out on a polarized proton target with a horizontal spin orientation. The target material is propanediol doped with Cr^V. A magnetic field of 2.5 T is produced by a pair of superconducting Helmholtz coils. The target polarization is typically 75% at the temperature of 0.6 K.

The main part of the measuring apparatus (fig. 1) is a multiplate polarimeter consisting of optical spark chambers with carbon electrodes. A special television measuring system is developed for information read-out from these chambers. Magnetostrictive spark chambers are used for detecting the scattered pions.

The construction of the Helmholtz coils restricts the solid angles available for emitting scattered pions and recoil protons, so for obtaining data in a rather wide angular range one has to perform several measurements at different values of angle α between the target polarization and the momentum of the incident pions. On the first stage experiments were carried out for π^-p scattering at energies 450, 530, 560, 600 MeV in the range of scattering angles corresponding in c. m. s. $\cos\Theta^* = -0.6 \div -0.9$. The value of angle α was equal to $-35°$. Some obtained results were published in ref. [1].

For the next series of experiments the disposition of apparatus was changed in such a manner that the covered scattering angles corresponded to $\cos\Theta^* = -0.4 \div -0.7$; angle α was chosen to be $+10°$. The scattered pions were emitted in this case through a gap between the Helmholtz coils. The results obtained for the energy 560 MeV [2] are shown in fig. 2. Each point contains

all the statistics which was stored during the experiment — without any additional binning. Shown by curves are the predictions of three existing phase-shift analyses. Some preference can be given to the analyses VPI [3] and KH [4]. The final choice between them will be made after processing the data obtained at other energies.

REFERENCES

1. *Abaev V. V. et al.* // Yad. Fiz. 1988. 48. 1338
2. *Abaev V. V. et al.* Book of abstracts of the 3rd International symposium on pion-nucleon and nucleon-nycleon physics (Gatchina, April 17-22, 1989). P. 85.
3. *Arndt R. A. et al.* // Phys. Rev. 1985. D 32. 1085.
4. *Hohler G.* Handbook of pion-nucleon scattering. Physics Data No 12-1. 1979.
5. *Cutkosky R. E. et al.* // Phys. Rev. 1979. D 20. 2804.