Measurement of the polarization parameter P in elastic π^+p scattering in the energy range 500–600 MeV

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The polarization parameter P in the elastic π^+p scattering has been measured at 510, 530, 560, and 580 MeV for the angles $\cos\theta^* < 0$. The absolute measurement error is $\Delta P \approx \pm 0.1$. The obtained results were used to verify the isotopic-spin ratios.

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As part of the overall program of investigation of πp interaction in the High Energy Physics Laboratory of the B. P. Konstantinov Leningrad Institute of Nuclear Physics, Academy of Sciences of the USSR, the polarization parameter P was measured in the elastic π^+p scattering in the energy range 500–600 MeV. In this energy range the angular dependence $P(\theta^*)$ changes sharply at scattering angles greater than 90°, and accurate measurements with a small increment of the π-meson energy must be performed in order to determine this dependence reliably. On the other hand, the results of experiments performed so far have errors at the level $\Delta P \approx \pm(0.3\text{–}0.5)$ in

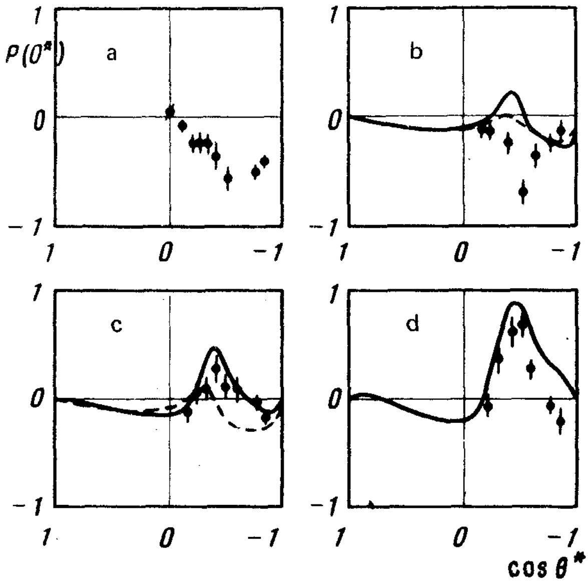

FIG. 1. The results of measurement of the polarization parameter in the elastic π^+p scattering at (a) 510 MeV, (b) 530 MeV, (c) 560 MeV, and (d) 580 MeV. The solid curves represent the predictions of the KN-78 phase analyses and the dashed curves denote the predictions of the LIYaF-78 phase analyses.

this range of angles (this reflects primarily the difficulties arising due to the small differential cross sections for elastic π^+p scattering); such a low accuracy makes it impossible to determine the angular dependence $P(\theta^*)$ even qualitatively.

In our experiment we have performed measurements in the region $\cos\theta^* < 0$, using the π-meson channel[1] of the LIYaF proton cyclotron and the polarized proton target made from a double lanthanum-magnesium nitrate; the average polarization of the proton target was 50%. The main track element of the detecting apparatus was a stack of four, 0.5 X 0.5-m wire spark chambers with a 1-mm spacing between the wires. This arrangement made it possible to determine the direction of particles with an accuracy to within several tenths of a degree. In our experiment we used five stacks of spark chambers. A detailed description of the experimental setup is given in Ref. 1.

The polarization parameter P was measured at the energies 510, 530, 560, and 580 MeV; measurements were performed for each energy using a polarized target and a special "background" target without hydrogen. The results of the experiment, shown in Fig. 1, are much more accurate (typical error $\Delta P \approx \pm 0.1$) than the currently available data. These results show unambiguously that the angular dependence of the parameter P changes sharply in the region of angles $\cos\theta^* < 0$ as a result of transition from 530 MeV to 580 MeV.

Figure 1 also shows the curves calculated on the basis of the two latest phase analyses KN-78 (Ref. 2) and LIYaF-78 (Ref. 3). We can see that neither of these

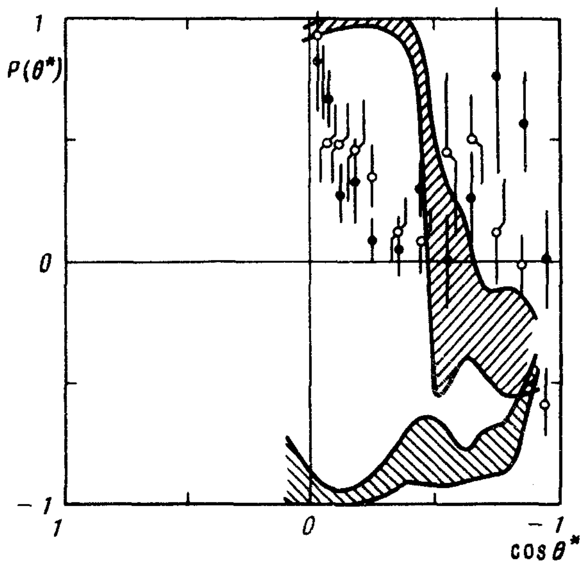

FIG.2. The boundaries of the resolved region for polarization in the charge-exchange scattering at 560 MeV (///–upper boundary; \\\–lower boundary) and the values of P_0 measured experimentally at 550 MeV (●) and at 572 MeV (○).

analyses describes that variation of the dependence $P(\theta^*)$ with increasing energy which has been observed in our experiment—the phase analyses predict that the flattening out of the curve $P(\theta^*)$ occurs at 530 MeV, whereas it actually occurs at a higher energy, 560 MeV. This indicates that a new phase analysis, which includes this energy region, must be performed.

The new data obtained in our experiment were used to verify the isotopic-spin ratios in the energy region 500-600 MeV. It is known that in order to satisfy the requirements of isotopic-spin invariance, the differential cross sections for elastic $\pi^{\pm}p$ scattering and for the scattering with the charge exchange I_+, I_-, and I_0, respectively, and the polarization parameters P_+, P_-, and P_0 in these processes must be connected by the following inequalities:

$$\sqrt{I_+(1\pm P_+)}-\sqrt{I_-(1\pm P_-)}\leqslant\sqrt{2I_0(1\pm P_0)}\leqslant\sqrt{I_+(1\pm P_+)}+\sqrt{I_-(1\pm P_-)}.$$

Using these relations, we can calculate the boundaries of the resolved region for any of the six values if the remaining five values are known.

We have performed such calculations for P_0 at an energy of 560 MeV, using the experimental data for P_-, I_+^0, I_-, and I_0 from Refs. 1, 4, and 5 and the values of P_+ from our experiment. The upper and lower boundaries calculated for P_0 were compared with the polarization in the charge exchange, which was measured directly at 550 and 572 MeV.[6] The results of such comparison are illustrated in Fig. 2; the errors, represented as hatched areas, include the experimental errors and interpolation errors. It can be seen that the values of P_0 measured in Ref. 6 are outside the boundaries of the resolved region for the angles $\cos\theta^* < -0.6°$; the observed systematic discrepancy cannot be explained by the random divergence of one or two points. Thus we can state that the currently available experimental data do not satisfy the isotopic-spin ratios for large scattering angles.

[1)]The particle beam had a pulse spread of 1.5% (total width at half height); the average pulse was determined with an accuracy of ±0.5%.

1. V. S. Bekrenev *et al.*, Yad. Fiz. **31**, 173 (1980) [Sov. J. Nucl. Phys. **31**, 92 (1980)].
2. G. Hohler *et al.*, Physics Data, No. 12-1, 1979.
3. V. V. Abaev *et al.*, Preprint LIYaF-438, 1978.
4. V. A. Gordeev *et al.*, Yad Fiz. **29**, 657 (1979) [Sov. J. Nucl. Phys. **29**, 339 (1979)].
5. R. M. Brown *et al.*, Nucl. Phys. **B117**, 12 (1976).
6. R. M. Brown *et al.*, Nucl. Phys. **B144**, 287 (1978).

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