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6.15 Measurement of the Longitudinal Analysing Power in $\vec{p}$-p Scattering*

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The analysing power has been measured using longitudinally polarized protons of 50 MeV on a 80 bar hydrogen gas target. The thickness of the target corresponded to a 10 MeV proton energy loss. The cross sections were averaged over an angular range of 40-135 degrees c.m.. A value of $Az=(-1.63 \pm 1.03)\times10^{-7}$ has been obtained.

The longitudinal analysing power Az in $\vec{p}$-p scattering is of great interest, as it is a measure for the parity violating part of the hadronic interaction. The measurement compares the cross section σ^+ for protons with positive helicity to the cross section σ^- for protons with negative helicity to calculate the value Az as:

$$Az = (\sigma^+ - \sigma^-)/(|Pz| \ast (\sigma^+ + \sigma^-)),$$

where Pz is the beam polarization. The difficulty in gaining the exact value for this observable stems from the minuteness of the expected asymmetry which is in the order of 10^{-7} (Ref. 1,2). This value is hard at the edge of todays experimental accuracy. To firmly establish this asymmetry as good as possible several groups have made independent measurements whose results can be compared (Ref. 3,4,5).

Since our first result (Ref. 6) several refinements were done to the experimental setup and the polarized ion source. Using the 50 MeV polarized proton beam of the 88" cyclotron at the Lawrence Berkeley Laboratory additional data for the longitudinal analysing power were obtained in a series of runs. The experimental setup is shown in Fig. 1.

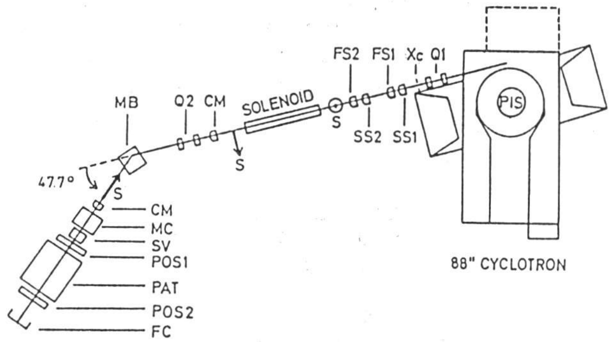

Fig. 1. The beam line and the experimental setup

PIS	Polarized ion source
Q1,2	Quadrupole doublets
FS1,2	Fast steering magnets
SS1,2	Slow steering magnets
CM	Centering magnets
MB	Bending magnet
MC	Monitor chamber
POS1,2	Position sensors
PAT	Target-detector assembly

The arrangement of the beam line elements is a crucial part of the setup, as they effect the spatial distribution of residual transverse polarization components inside the parity target which account for the biggest correction to the measured asymmetry.

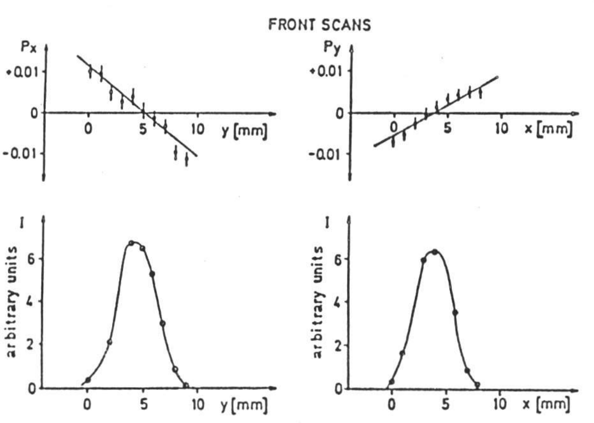

Fig.2. Polarization distribution, corresponding intensity profile.

The distribution of the two transverse polarization components were measured in front and at the rear of the target. Fig. 2 shows such a distribution measured in front of the target. The measured slopes of Py and Px behind the target show a similar behavior, so that the induced effects cancel in part each other.

False asymmetries which have to be corrected originate from a synchronous modulation of beam properties with the spin reversal.

Effects that arise from modulations inside the ion source and in conjunction with the cyclotron (e.g. possible energy modulation) are well suppressed by combining runs with different polarity of the precession solenoid. Coherent changes through the interaction of the aligned proton with the beam line and target have to be estimated and corrected exactly. Table I gives a list of the effects that have been taken into account and how they contribute to the final error.

Table I: Contribution of the corrections to the final error

Asymmetry effect	Induced error in 10^{-7}
- Beam intensity modulation	0.2
- Beam position and angle	0.4
- Emittance modulation	0.2
- Residual transverse polarization components	0.7
- Double scattering, β-decay	0.2
- Electronic asymmetry	0.2
- Pz normalization	0.05

Table II: Results for the two directions of the precession solenoid

Solenoid field	Raw asymmetry in 10^{-7}	Corrected asymmetry in 10^{-7}
+	-7.18 ± 1.05	-1.74 ± 1.38
-	-4.62 ± 1.27	-1.48 ± 1.56

The asymmetries measured for the two spin directions of the precession solenoid are very close. The combined values give a result of

$$A_z = (-1.63 \pm 1.03) \times 10^{-7}$$

Our measured longitudinal analysing power is in very good agreement with other experiments at comparable proton energies: (Ref. 3) yields Az (45 MeV) = $(-2.31 \pm 0.89)\times10^{-7}$, (Ref. 5) Az (47 MeV) = $(-4 \pm 3)\times10^{-7}$, (Ref. 4) Az (15 MeV) = $(-1.7 \pm 0.8)\times10^{-7}$, the latter has to be multiplied by 1.75 to be comparable with the 45 MeV result.

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