

6.5 New Measurement of Parity violation in $\vec{p}$ -p scattering at 45 MeV

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After a first measurement of parity violation in $\vec{p}$ -p scattering at 45 MeV¹⁾ and a similar investigation in $\vec{p}$ - α scattering²⁾ we decided to resume the experiment on $\vec{p}$ -p scattering in order to reduce the experimental uncertainty and to provide a more significant constraint on theories which predict such effects on the basis of gauge theories.

The experiment is performed at SIN and makes use of the Philips Injector Cyclotron with atomic beam type polarized ion source in which we reverse the polarization every 30 msec. The 50.7 MeV proton beam passes through a longitudinal 90° spin-precession solenoid and then is deflected horizontally by 47.6° in order to rotate the vertical polarization of the beam coming from the cyclotron ($\pm P_y$) into a longitudinal polarization $\pm P_z$ or $\mp P_z$ depending on the sign of the solenoid field. The protons are scattered in a 100 bar H₂ gas target and detected in a cylindrical ionization chamber of 20 cm outer radius and 2 cm active thickness, coaxial with beam and target. The quantity of interest is the longitudinal analyzing power A_z obtained from the expression

$$A_z = \frac{\sigma^+ - \sigma^-}{\sigma^+ + \sigma^-} = \frac{1}{|P_z|} \frac{(N_s/N_p)^+ - (N_s/N_p)^-}{(N_s/N_p)^+ + (N_s/N_p)^-} \equiv \frac{1}{|P_z|} R$$

where $\sigma^+(\sigma^-)$ is the cross section for incoming protons with positive (negative) helicity. N_s is the integrated ionization chamber current and N_p is the integrated beam current in the Faraday cup. Besides the accumulation of the necessary statistics, the main problem lies in the elimination of systematic errors from the measured asymmetry R .

Our new data have been acquired in 3 series numbered 3 to 5, containing a total of 183 20 min. data runs. The results, corrections and systematic uncertainties are compiled in Table 1. The principles of the data analysis and treatment of systematic effects are described in detail in ref. 1). However, several improvements have been implemented since these measurements (series 1 and 2), which results in considerable reduction of systematic effects.

The result of the new measurements, containing all systematic errors added quadratically, is

$$A_z = -(1.49 \pm 0.42) \times 10^{-7}$$

at an average lab. energy of 45 MeV. Including the earlier measurements¹⁾ (series 1 and 2) yields

$$A_z = -(1.63 \pm 0.37) \times 10^{-7}.$$

The distribution of the 183 new runs is shown in fig. 1. The χ^2/N_D is 171/181 corresponding to a confidence level of 64%. The distribution of the results of the 5 series yields $\chi^2/N_D = 4.71/4$ (confidence level 32%). This shows the consistency of the data.

Theoretical analyses usually refer to the analyzing power A_z^{tot} in the total cross section which due to slight angular dependence of A_z and reduced angular acceptance of the detection system¹⁾ differs by a somewhat model dependent factor $(1.05 \pm 0.05)^{1)}$ from the actually measured result A_z . Thus our result translates to

$$A_z^{\text{tot}}(45 \text{ MeV}) = -(1.71 \pm 0.40) \times 10^{-7}.$$

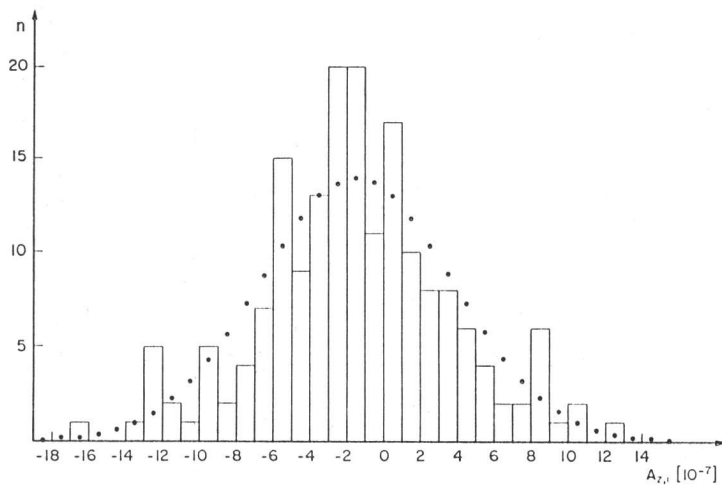
The measurements will be continued with the aim to reduce the overall uncertainty to below 3×10^{-8} .

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Table 1. Summary of results, corrections and systematic uncertainties in units of 10^{-7} .

	Serie 3	Serie 4	Serie 5
Number of 20-min. runs	51	84	48
'raw' asymmetries R	-1.47 ± 0.54	-1.06 ± 0.43	0.41 ± 0.60
<i>Systematic uncertainties and corrections:</i>			
Transv. pol. components	-1.13 ± 0.08	0.66 ± 0.06	0.98 ± 0.08
Intensity modulations	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Position modulations	0.06 ± 0.14	0.03 ± 0.12	0.54 ± 0.40
Emittance modulations	± 0.071	± 0.034	± 0.075
Energy modulations	± 0.17	± 0.008	± 0.042
Electronic cross talk	± 0.00	± 0.00	± 0.00
Corrected asymmetries	-0.41 ± 0.59	-1.74 ± 0.45	-1.12 ± 0.74
Beam polarization $ p_z $	0.82	0.81	0.83
long. analyzing power A_z	-0.50 ± 0.73	-2.15 ± 0.57	-1.35 ± 0.90
Average		-1.49 ± 0.40	
<i>Common uncertainties:</i>			
β -decay		± 0.04	
Background		± 0.11	
Double scattering		± 0.02	
Beam polarization		± 0.04	
Result for A_z		-1.49 ± 0.42	

Fig. 1.
Distribution of the results $A_{z,i}$ of 20 min. runs compared to the theoretical expectation.



References

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