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A Measurement of C_{SS} and $\Delta\sigma_T$ in pp Elastic Scattering at 500, 650 and 800 MeV (Experiment 512,EPB)

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A measurement of the pp elastic scattering spin parameters are essential in determining the I = 1 amplitudes as well as contributing to the determination of phase shifts. The measurements of single and double-spin correlation parameters at each angle and energy will have a large impact on these programs. Furthermore, a study of the two-spin elastic scattering parameters may reveal possible new structure in the pp system.

Experiment 512 has as its objective to measure C_{SS} in the angular region $20° \lesssim \theta_{c.m.} \lesssim 90°$ and at energies of 500, 650 and 800 MeV. The EPB beam, polarized in the S direction, was incident to a target also polarized in the S direction. The scattered particles were detected in a single arm spectrometer which rotated from about 0° to 45° in the lab. A simultaneous measurement of $\Delta\sigma_T$ was made using the transmission counters from Experiment 498[1] downstream of the spectrometer. The beam polarization was checked with a CH_2 polarimeter, also from Experiment 498.

In June and July, the frozen-spin polarized target system was tested in EPB and then shut down until E-512 began in September. The target system consisted of the ANL horizontal dilution refrigerator fixed on the beamline and the HERA superconducting magnet on a moveable transport.[2] With a conventional polarized target in an S-type configuration, the HERA magnet would allow only a small acceptance from 0-7° and 45-135° in the lab. In the frozen-spin mode of operation, the ethylene glycol target was polarized by microwave pumping in a field of 2.5T and at a temperature around 400mK. After polarization of 80% was attained, the target temperature was reduced to 30-50 mK and the HERA magnet moved away from the beamline keeping the target in a reduced magnetic holding field of typically around 300 mT. This therefore, enabled the lab angular acceptance of the experiment to be from 0° to 90°.

Figure 1 shows the target relaxation times (1/e) as a function of the holding field for various temperatures. Holding times of 400-500 hours were typical at 310 mT holding fields. The absolute temperatures quoted in the figure are probably high. This uncertainty was mainly due to instrumental effects and resistor calibrations at these low temperatures. Furthermore, it was determined that beam heating of the target became a problem only if the flux were $\gtrsim 2 \times 10^5/\mathrm{sec/cm}^2$, well above our normal beam intensity for data taking.

The spectrometer consisted of a C-magnet (Hermes) with proportional chambers of 1 mm effective spacing. The current in Hermes was set to give a bend angle of 11° at any given lab angle and the spectrometer acceptance was about 3.5 msr. The momentum resolution was better than 1.5% and hence the single-arm method allowed separation of the pp elastic events from pC quasi-elastic events at lab angles $\gtrsim 10°$. A carbon slab placed upstream or downstream of the polarized target enhanced our background for the further study of the quasi-elastic events.

The beam was defined by two scintillators in the beam and two annular veto counters. Polaroids and beam steering tests ensured the polarized target, scintillators and beam were aligned to within ± 1 mm. Typical beam intensities were 2 x 10^5 p/sec in a 15 mm spot at the target.

Figure 2 shows preliminary C_{SS} data over the angular range of the experiment for the three energies. Also shown in the figure are phase shift predictions from Arndt and Kanada.

Because of the greatly reduced polarizing field, the beam does not get bent passing through the target region as much as with the traditional fields. Systematic errors due to misalignment of counters are greatly reduced. To take advantage of this situation, the transmission counters of E-498 were used to measure $\Delta\sigma_T$ with this reduced holding field.[3] The positions of the transmission counters were held fixed and, as beam energy changed, the holding field was varied so that the beam trajectory remained constant. Thus, false asymmetries due to misalignment of the beam are minimized.

To minimize accidentals corrections in the $\Delta\sigma_T$ measurement, the beam intensity was reduced to about 10^4 p/sec. Figure 3 shows the corrected data obtained in E-512 in comparison with previous data and the available phase shifts claiming $^1D_2$ and $^3F_3$ dibaryon resonances. The existing data are not sufficient to clarify the existence of $^3P_0$ or $^3P_2$ resonances. Data with fine energy steps around 650 MeV will be important.

References

1) I. P. Auer et al., Phys. Rev. D24, 2008 (1981).

2) D. Hill et al., Proceedings of the Workshop on Polarized Targets and Materials, Brookhaven National Laboratory, Upton, New York, September, 1982.

3) W. R. Ditzler et al., Phys. Rev. D27, (1983).

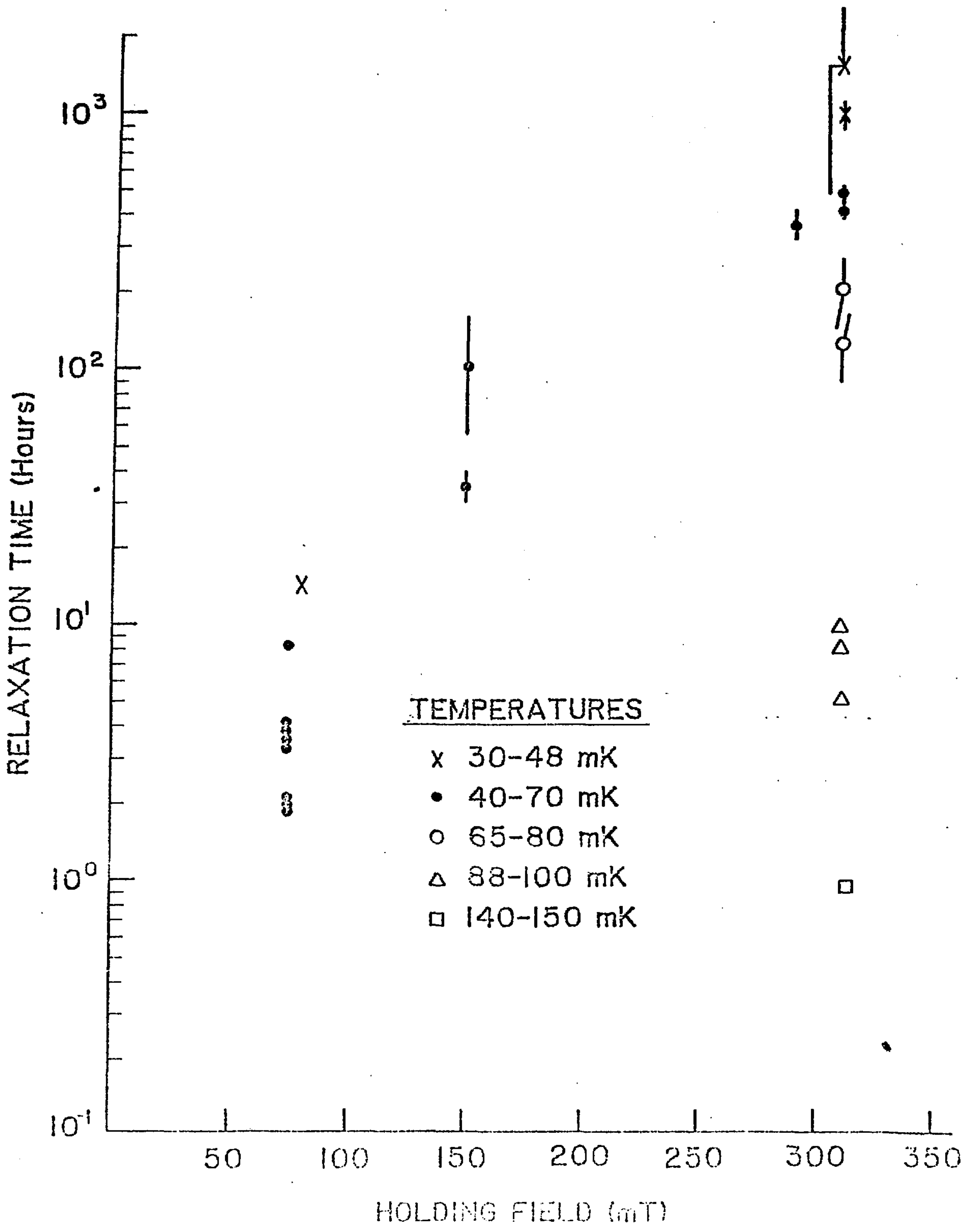
4) D. Axen et al., J. Phys. G7, L225 (1981);
E. K. Biegert et al., Phys. Lett. 73B, 235 (1978).

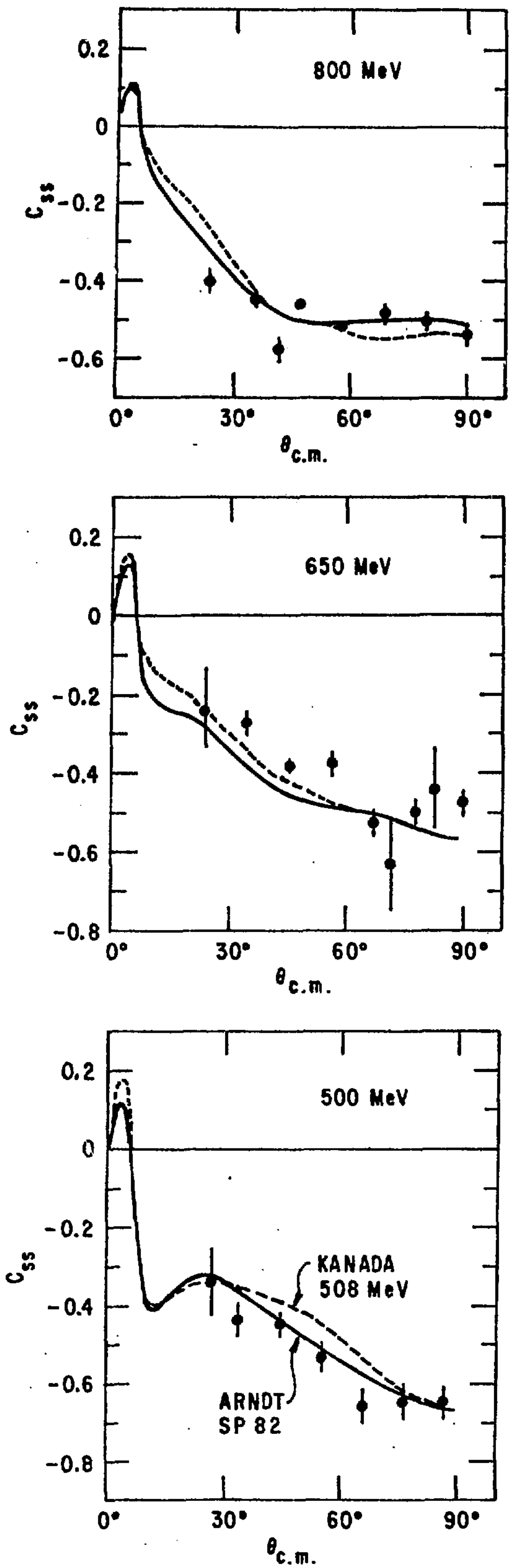
FIGURE CAPTIONS

Figure 1 The relaxation time versus holding field of the E-512 polarized target. Shown are various temperature regions from 30-150 mK. The scatter in the data for a given temperature is mainly due to instrumental uncertainties in the temperature measurement. At 310 mT, typical relaxation times were found to be 400-500 hours.

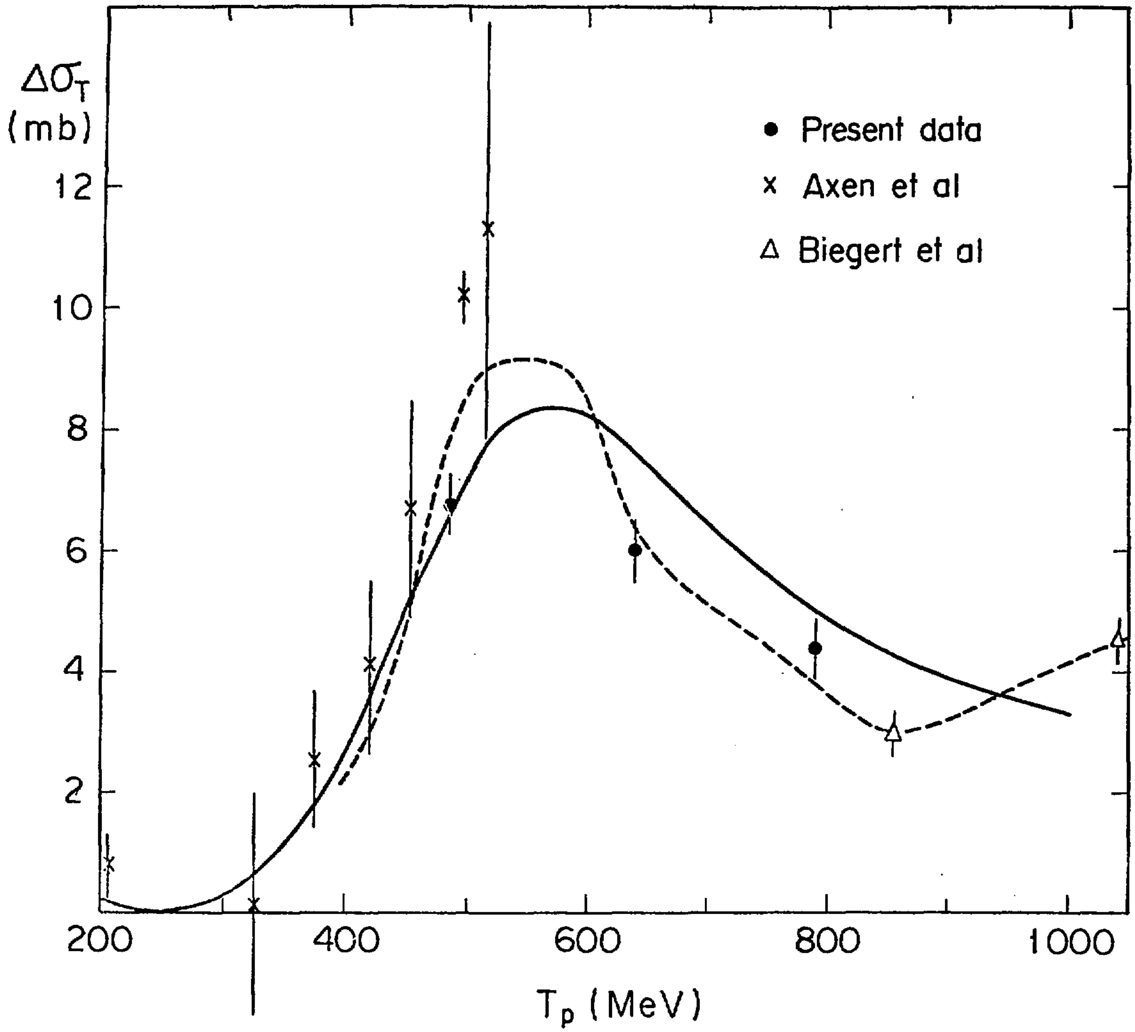
Figure 2 Preliminary C_{SS} data for pp elastic scattering in the angular range of $20^\circ \lesssim \theta_{c.m.} < 90^0$. Also shown are phase shift solutions from Arndt (Spring 82) and Kanada.

Figure 3 $\Delta\sigma_T$ vs. incident beam energy. Previous data from Axen et al., and Biegert et al. are also shown.[4] The solid line is Arndt's phase shift prediction and the dashed line is from Hoshizaki.


RELAXATION TIME (Hours)
10^3
10^2
10^1
10^0
10^{-1}
TEMPERATURES
x 30-48 mK
• 40-70 mK
o 65-80 mK
△ 88-100 mK
□ 140-150 mK
50
100
150
200
250
300
350
HOLDING FIELD (mT)



800 MeV
650 MeV
500 MeV
KANADA
508 MeV
ARNDT
SP 82
C_{ss}
$\theta_{c.m.}$
0.2
0
-0.2
-0.4
-0.6
-0.8
0°
30°
60°
90°



ΔσT
(mb)
12
10
8
6
4
2
200
400
600
800
1000
Tp (MeV)
● Present data
× Axen et al
Δ Biegert et al

DISCLAIMER