MEASUREMENT OF A AND A_{nn} IN ELASTIC pp AT 18.5 GeV/c*

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ABSTRACT

Measurements of A and A_{nn} are reported for 8 $p_\perp^2$ values from 1.40 to 3.35 $(GeV/c)^2$. Both show pronounced dips in this region: A at ~ 3.0 and A_{nn} at ~ 2.3 $(GeV/c)^2$. It is remarked that we have no current model for associating these dips, and that a significant comparison might first be available from extensive plots of A and A_{nn} against p_{lab} and $p_\perp^2$.

Here we report on some recent polarization measurements[1] in pp elastic scattering: A and A_{nn} at 18.5 Gev/c. These are part of an ongoing program at Brookhaven National Laboratory, where currently the highest energy polarized proton beams are available for general use. Figure 1 indicates the potential scope of this program in a 3-dimensional projection of A_{nn} against p_{lab} and $p_\perp^2$, the transverse momentum squared. The challenge is to fill in the landscape with enough hills and valleys to form a perceptible pattern. The analogy is strong to neutron cross section measurements[2] on nuclei, which were the birthplace of the nuclear optical model. One hopes for a similar, overarching simplicity in the present case. The difficulty of the program is emphasized by looking along the 18.5 GeV/c line. The shaded areas plot the data reported here, gathered in a couple of months' run last winter; the x's along the same axis represent data points attainable in a projected run of comparable magnitude. Clearly at this rate it will take longer to fill in the pattern than in the nuclear case.

To preserve beam polarization while accelerating to ~ 20 GeV/c in a strong focusing machine is a difficult trick because of the many depolarizing resonances. In the AGS imperfection resonances form a "picket fence", occurring about once every 0.5 Gev/c. These are compensated by 96 correction dipoles, which are tuned in a commissioning run. A second class, intrinsic resonances, arises from coupling of the vertical betatron motion and cannot be corrected in this way; rather the betatron frequency is suddenly shifted as the beam energy approaches the resonance, which minimizes the transversal time and hence the depolarization. For this a set of fast pulsed quadrupoles proved necessary, and 10 out of a maximum possible 12 have been installed. The entire polarization program was spearheaded by a University of Michigan[3] group and is now managed by the AGS Department at BNL.

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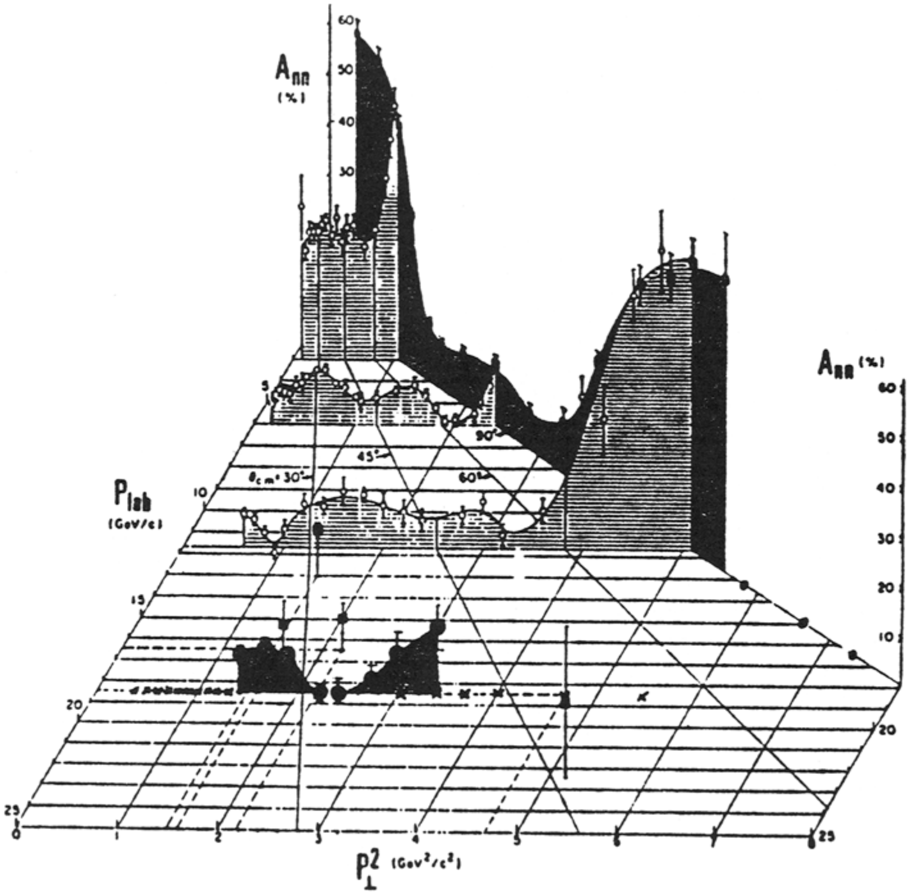

Figure 1. "Landscape" plot of A_{nn}.

Figure 2 shows the layout of this experimental run. The beam averaged ~ 2 x 10^{10} polarized protons per pulse at ~ 0.4 pulses/sec. (peak ~2.5 x 10^{10} pppp) with an average polarization of 43 ± 3% (peak ~ 52%). The high energy polarimeter on the left of Fig. 2 monitored the beam polarization as it entered the experimental region to have a vertical polarization of 41 ± 3% (a 2% loss at bends in the beam line from the AGS); scintillation counter telescopes M, N and K helped monitor relative beam intensity. The polarized proton target is labeled PPT in Fig. 2; elastic scattering events were measured in the double arm spectrometer downstream. The elimination of background by this spectrometer was very good, as teflon target runs showed only about a 6% effect, for which the data were corrected.

During the run we recorded ~ 340,000 events at 8 different $p_\perp^2$ values from 1.40 to 3.35 $(GeV/c)^2$. This works out to an

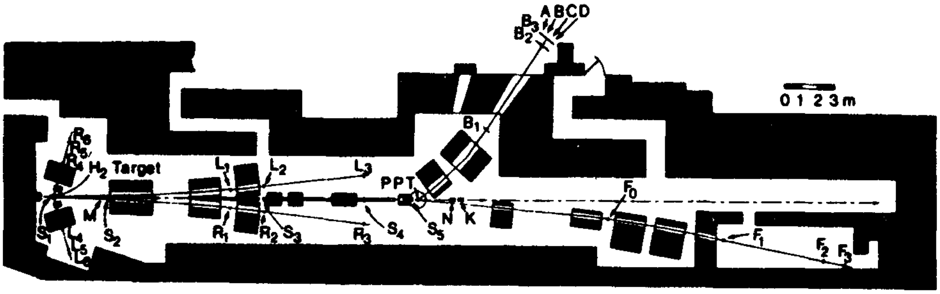

Figure 2. Target and spectrometers.

average of around 1 event per AGS pulse. Figure 3 displays the results: both A and A_{nn} showing pronounced dips - at $p_{\perp}^2 \sim 3.0$

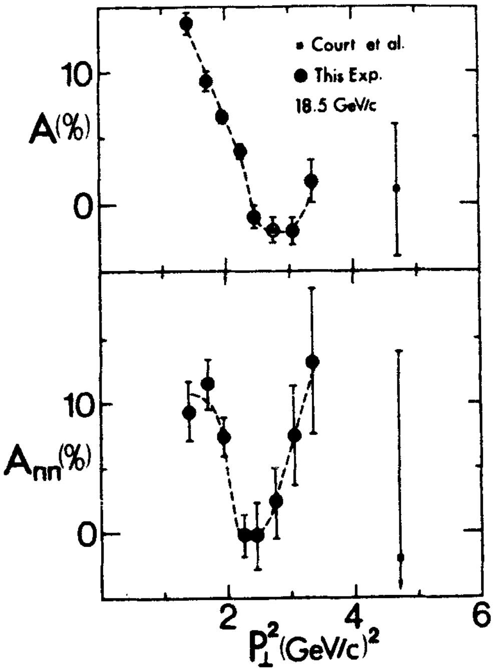

Figure 3. Experimental results.

$(GeV/c)^2$ for A, $p_\perp^2$ ~ 2.3 $(GeV/c)^2$ for A_{nn}. The improvement in polarized beam running is seen by comparing the error bars from the run 2 years previousely[4]. A consistency check is available from independent measurements of A_B and A_T afforded by the beam and target polarizations: a weighted average of $\langle A_B - A_T \rangle = 0.4 \pm 0.7\%$ over the target run.

To our present understanding A and A_{nn} arise from effective potentials of entirely different character - spin-orbit and spin-spin, respectively - so there is no reason to expect similar behavior. It should therefore be significant to prepare a plot of A similar to Fig. 1 for A_{nn}. Ultimately for each parameter a systematic set of connected hills and valleys should emerge. Their similarities and differences might provide insight into their origins - e.g., allow some recognition of common features reflecting overall nucleon structure, to be contrasted with variations revealing specifics of spin-orbit or spin-spin interactions.

REFERENCES

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