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FERMILAB PROPOSAL

A SEARCH FOR PROTON POLARIZATION IN INCLUSIVE PRODUCTION AT 300 GeV/c

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ABSTRACT

We propose a search for proton polarization in inclusive production in the same kinematic region in which E8 observed substantial Λ polarization. The targeting of the Meson Lab can be changed so that the M2 line no longer transports a diffracted beam, but one produced with a transverse momentum of 1-1.5 GeV/c. (Λ's produced in this region were found to be 15%-28% polarized, and proton polarizations of at least this magnitude might be expected.) The existing E8 apparatus in the M2 line can be used as an analyzer of proton polarization; any polarization observed among forwardly produced Λ's would be an indication of an incoming proton polarization. We request 100 hours of running in the retargeted Meson Lab M2 beam.

E8[1] has found substantial Λ polarization in inclusive production for $p_\perp \geq 1$ GeV/c. This polarization was independent of x, and increased linearly with $p_\perp$ to 28% at $p_\perp = 1.6$ GeV/c. No theoretical model satisfactorily explains this effect, but it would seem unlikely that Λ's are unique among the baryons. Therefore, a search for proton polarization in the same kinematic region in which Λ polarization was seen might prove fruitful. Whatever the result of the search, it would have to be incorporated into a theory explaining the Λ effect; and if the results were positive, it would mean that everyone has been using polarized protons all along!

The present E8 apparatus is in the M2 (diffracted proton) beam in the Meson Lab. By steering the primary proton beam to a larger angle than usual, the M2 line can be made to transport protons at 3-4 mrads, i.e., with $p_\perp \geq$ 1 GeV/c. These protons may be polarized, and the existing E8 apparatus can serve as their analyzer by measuring the spin transfer to forward Λ's. Here, Λ production is copious and as no polarization has been observed, any such observation would indicate an incoming proton polarization.

For 1 GeV/c $< p_\perp <$ 1.5 GeV/c inclusively produced Λ's were observed to be 15%-28% polarized. Since no distinction between Λ's produced directly and those arising from Σ^0 decay was made, the actual Λ polarization is most likely greater. It seems conservative to direct the present proposal to the detection of a polarization of 0.10 with statistical error of 0.01. Such a measurement would require the analysis of about 200,000 Λ's. This is well within the capabilities of the existing apparatus, which has already analyzed over 1.2×10^6 Λ's for polarization.

The principal difficulty, of course, is the Meson Lab retargeting. We performed some tests with the limited existing steering capabilities and were able to get the M2 line to 1.5 mrad. (At 300 GeV/c, this represents a $p_\perp$ of 0.45 GeV/c.) The particle yield was about 2×10^6, producing about 350 triggers/pulse. Of these, 12% reconstructed as Λ's -- about 1/4 the usual Λ/trigger ratio. We attribute the increased background to γ's produced from π^+ in the nondiffracted beam. The Λ yield/incident particle was the same as usual, so the π^+ are a small contamination producing a large background. (The Cal Tech group measured the π^+ contamination to be $<$ 5% at 300 GeV/c.) Unfortunately, the tests did not produce a conclusive result

on proton polarization. In one shift or so of running, we obtained a sample of 18,000 Λ's with $0.8 < x < 1$. For this sample, we measured $D \cdot P = 0 \pm 0.05$, where P is the proton polarization and D the spin transfer between proton and forward Λ. (For large x, D is expected to be large.) The polarization of Λ's produced with $p_t = 0.45$ GeV/c was found to be 0.06 ± 0.02.[1] The null proton result is consistent with the small Λ polarization, and we conclude that the technique works. However, a meaningful measurement requires going to a larger proton angle. Herein lies the difficulty.

Jeff Appel has looked at the Meson Lab targeting in considerable detail and has concluded that going to a larger angle is feasible.[2] The present steering limitation is imposed by magnet apertures; going to a larger angle requires moving hardware. His estimate is that it will take two days to move the necessary magnets so as to permit steering the beam to 4 mrads, and two days to restore them. While the Meson Lab targeting is adjusted so that M2 is at 4 mrads, all the other beam lines will be affected. The most serious effects will be in the spectra of neutral beams (M3, M4). Experiments using these beams might choose not to run; for those using charged beams, only rates will change.

Our test run showed that with 2×10^6 protons/pulse, we can expect about 40 Λ's/pulse, of which 20% have $x > 0.8$. Thus, in 100 hours of running, we can acquire 200,000 high x Λ's. We request this time.

References

1. G. Bunce, et al. Phys. Rev. Lett. 36, 1113, (1976).

2. Memo: J. Appel to C. Brown.