FERMILAB-CONF-08-563-E

Λ^0 Polarization in pp→pΛ^0K$^+$ at 800GeV/c

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Abstract. We determined Λ^0 polarization as function of X_F, P_T, M_X, and E_Λ, with respect to the normal of the following two different production planes: The first one defined by the momentum of the 800 GeV/c proton beam and the moment of Λ^0; the second one, by the momentum of the transferred object and the momentum of Λ^0, from the sample created in the FNAL E690 experiment. We present results, compare and discuss them.

Keywords: Polarization, Production plane, spin
PACS: 13.88.+e, 13.85.Hd, 14.20.Jn

INTRODUCTION

The experiment E690 investigated proton-proton collisions using an 800GeV/c proton beam incident on a liquid Hydrogen target. The E690 detector apparatus consisted of two separate spectrometers; a beam spectrometer and multi-particle spectrometer [1]. The data analysis was done in four steps as follows: Track reconstruction, vertex reconstruction, particle identification, and selection of exclusive events. This experimental study was on a sample of 41899 events obtained with the following cuts: $(\Delta P_T)^2 < 0.001$(GeV/c)^2 and -0.02GeV< $\Delta(E-P_L) < 0.015$GeV, defining exclusive events. The Figure 1 shows the mass distributions.

Important in this study are the following concepts: Invariant mass (M_X), the mass of diffracted object (Λ^0 and K^+); transversal momentum (P_T), the transversal momentum of Λ^0 with respect to the incoming beam proton; Feynman scaling parameter (X_F), the longitudinal momentum of Λ^0 measured in the reaction center of mass with respect to the incoming beam proton divided by its maximum possible value; transferred momentum (P_X), the transferred momentum from the incoming beam proton to the target proton -it is also the sum of Λ^0 momentum and K^+ momentum-; energy of Λ^0 (E_Λ), energy of lambda measured in laboratory coordinate system; production plane defined by the Λ^0 momentum and the beam momentum [2]: $\hat{n} = (\vec{P}_i \times \vec{P}_\Lambda)/|\vec{P}_i \times \vec{P}_\Lambda|$, where i is the incoming beam proton momentum or the

Operated by Fermi Research Alliance, LLC under Contract No. De-AC02-07CH11359 with the United States Department of Energy

momentum of the transferred object; and polarization, the expectation value of particle spin with respect to some quantization axis [3]: $P = \langle \vec{s} \cdot \hat{n} \rangle$.

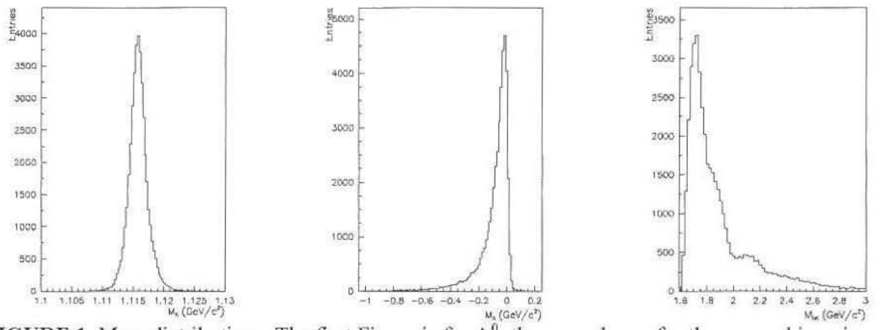

FIGURE 1. Mass distributions. The first Figure is for Λ^0; the second one, for the squared imaginary mass of the transferred object; and the third one, for (Λ^0 and K^+) system.

TECHNIQUE TO MEASURE Λ^0 POLARIZATION

The technique used to measure polarization of Λ^0 consists on fitting to a straight line the Λ^0 decay angular distribution determined in the Λ^0 rest frame; the slope of the fit is directly proportional to the Λ^0 polarization [4]: $dN/d\Omega = N_0(1-\alpha P\cos\theta)$, where dN is the number of protons from the Λ^0 decay inside the solid angle $d\Omega$, N_0 is a normalization constant, the asymmetry parameter α is 0.642 $\pm$ 0.013 [6], P is the Λ^0 polarization along the normal to the production plane, and the angle θ is formed by the momentum of the proton from Λ^0 and the normal to production plane in the coordinate system where Λ^0 is at rest.

RESULTS

The Figures 2, 3, and 4 show the results on Λ^0 polarization.

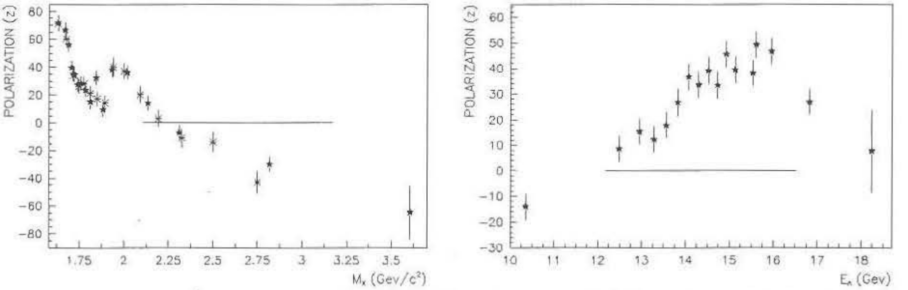

FIGURE 2. The Λ^0 polarization as function of invariant mass (left Figure), asterisk data is from Reference [5]; and right Figure, as function of Λ^0 energy.

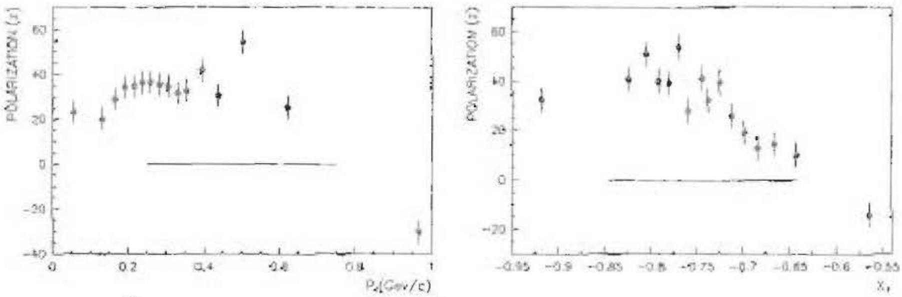

FIGURE 3. Λ^0 polarization as function of transversal momentum and as function of Feynman scaling parameter -respectively- with respect to the normal of the first production plane.

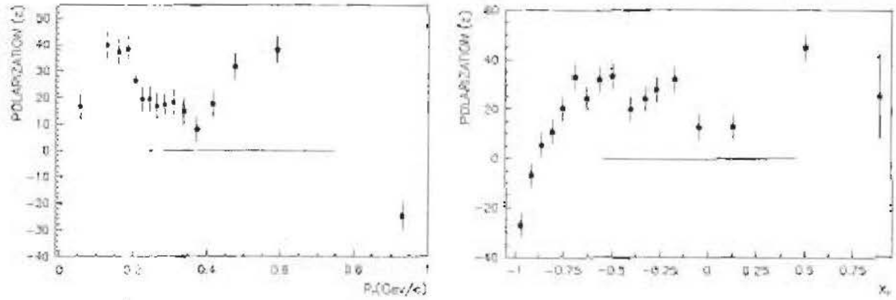

FIGURE 4. Λ^0 polarization as function of P_T and X_F -respectively-, with respect to the normal of the second production plane.

CONCLUSIONS

Λ^0 polarization as function of M_x agree with Reference [5] results, it depends also on the energy of the Λ^0, and on the normal of the production plane.

The comparisons of these results can give new information on role that particle spin plays in the production of high energy particles and on the origin of Λ^0 polarization.

ACKNOWLEDGMENTS

This work was partially supported by Universidad de Guanajuato –apoyo a la investigación convocatoria 2007–. CONCYTEG and CONACYT 39941.

REFERENCES

1. M. Whang,"Diffractively Produced Charm Final States in 800GeV/c Proton-Proton Collisions", Ph. D. Thesis, University of Massachusetts, Amherst, 2000.
2. A. Lesnik et al, Phys. Rev. Lett. **35**, 770(1975).
3. G. Bunce et al, Phys. Rev. Lett. **36**, 1113(1976).
4. J. Félix, Rev. Méx. Fis. **45**, 421(1999).
5. J. Félix et al, Phys. Rev. Lett. **88**, 061801-1(2002).
6. Particle Data Group, Phys. Lett. **B**. 592(2004).