Λ^0 Polarization in Exclusive pp Reactions From the FNAL e690 Experiment

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Abstract.
It is an experimental evidence that all baryons are created polarized from unpolarized $p-nucleus$ collisions. So far, the origin of this polarization remains unexplained in spite of the experimental evidences accumulated in the past thirty years. Up to these days, Λ^0 is the most studied baryon for polarization, for it is copiously produced in $p-nucleus$ collisions at the energies of the principal high energy physics accelerators of the world. This paper is an overview of the experimental evidences accumulated on the polarization of Λ^0 from unpolarized exclusive pp collisions as function of x_F, P_T, and M($\Lambda^0 K^+$) in the past fifteen years inside Fermilab e690 experiment, in the particular reactions $pp \to p\Lambda^0 K^0 \pi^+$, $pp \to pp\Lambda^0\overline{\Lambda}^0$, $pp \to p\Lambda^0 K^+$, produced at 800 GeV.

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INTRODUCTION

Many experiments have reveal that baryons from unpolarized pp inclusive and exclusive collisions, at different energies, are produced polarized[1] -specially Λ^0[2]-; and that this polarization depends on x_F, P_T, and $\Lambda^0 K^+$ invariant mass[3].

Some authors have proposed many theoretical ideas trying to understand Λ^0 polarization[4]. These models lack of predictive power, and the problem of Λ^0 polarization, and in general of baryon polarization, remains as an open problem. Some experiments have been conducted to measure Λ^0 polarization, in exclusive pp collisions, trying to unveil Λ^0 polarization origin studying specific final states where Λ^0 is produced.

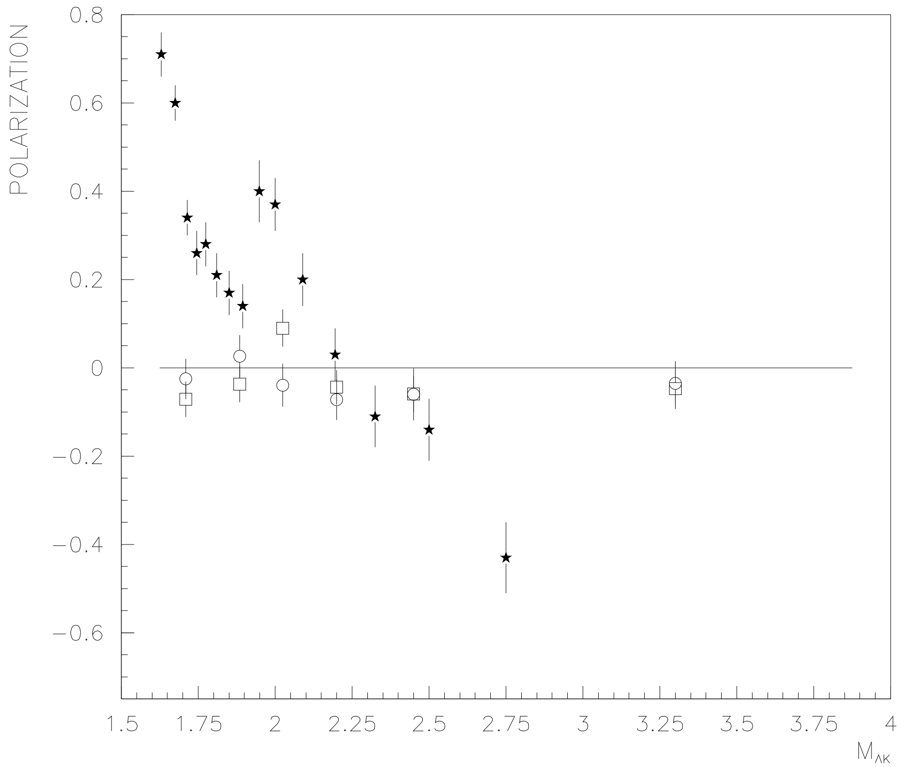

FIGURE 1. Λ^0 polarization as function of $M_{\Lambda^0 K^0}$ invariant mass. These results are consistent with zero, open circles and squares.

This paper reports the results of a study of Λ^0 polarization, as function of X_F, P_T, and $M_{\Lambda^0 K^+}$, in the specific final states

$$pp \rightarrow p\Lambda^0 K^0 \pi^+. \tag{1}$$

$$pp \rightarrow pp\Lambda^0 \overline{\Lambda}^0. \tag{2}$$

$$pp \rightarrow p\Lambda^0 K^+. \tag{3}$$

created in the experiment FNAL e690 at 800 GeV, where all final-state particles are measured and identified.

The way Λ^0 polarization is measured, and the definition of all variables, are described elsewhere[5].

E690 EXPERIMENT

The data for this study were recorded at Fermilab, experiment e690, described in detail elsewhere[5, 6]. For this study 37 000, 6 000, and 47 000 Λ^0's, from the reactions 1, 2, and 3 in that order, satisfied selection criterium cuts reported elsewhere[5, 6, 7].

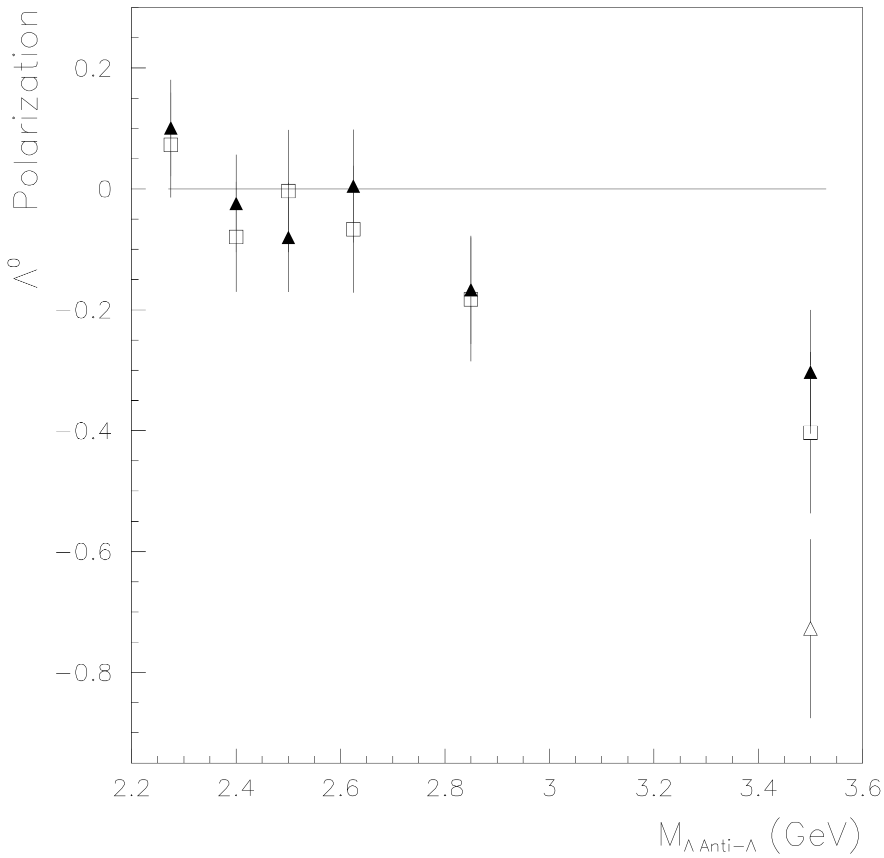

FIGURE 2. Λ^0 polarization as function of $M_{\Lambda^0\overline{\Lambda}^0}$ invariant mass. These results are not consistent with zero.

A Monte Carlo study was run, that faithfully describes all the characteristics of the detector and that of the particular reactions of Equations 1, 2, and 3, to study the effects of the acceptance on the Λ^0 polarization measurements. At first order acceptance corrections are irrelevant.

Λ^0 POLARIZATION RESULTS

This study of Λ^0 polarization explores the dependence of polarization on the kinematic variables P_T, x_F and $M_{\Lambda^0 X}$ invariant mass -where X is a K^0, K^+, or $\overline{\Lambda}^0$- in the final states represented by Equations 1, 2 and 3. The results of Λ^0 polarization are in Figure 1, as function of $M_{\Lambda^0 K^0}$ invariant mass, for reactions like Equation 1; this is consistent with zero and has not been observed previously -star data is from Reference[7], open circles and open squares are these results corrected by acceptance and uncorrected by acceptance, in that order-. For reactions like Equation 2, as function of $M_{\Lambda^0\overline{\Lambda}^0}$ invariant mass, the results are in Figure 2; this is not consistent with zero and this is the first time that the polarization of Λ^0 and $\overline{\Lambda}^0$ are observed in the same reaction -filled triangles and open squares are these results corrected and uncorrected by acceptance, in that order, open triangle is a measurement with more restrictive X_F cut-. For reactions like Equation 3, as function of $M_{\Lambda^0 K^+}$ invariant mass, the results are consistent with those reported in Reference [7]. Changing the plane of production does not change the polarization results as function of $M_{\Lambda^0 K^+}$ invariant mass in an appreciable way.

CONCLUSIONS

Λ^0 polarization in reactions 1, 2, and 3 depends on x_F, P_T, $M_{\Lambda^0 X}$ -where X is a K^0, K^+, or $\overline{\Lambda}^0$. Therefore, provide that there is energy enough in the reaction to create Λ^0, its polarization is independent of the beam energy.

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