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Λ^0 POLARIZATION IN $pp \to p\Lambda^0 K^+(\pi^+\pi^-)^5$ AT 27.5 GeV*

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The polarization of 1973 Λ^0's from the specific reaction $pp \to p\Lambda^0 K^+(\pi^+\pi^-)^5$ created by 27.5 GeV incident protons on a liquid hydrogen target, as a function of x_F, P_T, and $M_{\Lambda^0 K^+}$, is, within statistics, consistent with the polarization of Λ^0's from $pp \to p_{fast}\Lambda^0 K^+$ at 800 GeV.

1. Introduction

It is experimentally established that Λ^0's from unpolarized pp inclusive and exclusive collisions, at different energies, are produced polarized [1]; that this polarization depends on x_F, P_T, and $\Lambda^0 K^+$ invariant mass [2]. Additionally, other baryons like Ξ, Σ, etc., are produced polarized in the same experimental circumstances [3].

Authors have proposed many theoretical ideas to try to understand Λ^0 polarization [4]. These models lack predictive power, and the problem of Λ^0 polarization, and in general of baryon polarization, remains open. Some experiments have been conducted to measure Λ^0 polarization, in exclusive pp collisions, trying to unveil the origin of Λ^0 polarization by studying specific final states where Λ^0 is produced. This paper reports the results of a study of Λ^0 polarization in the specific final state

$$pp \to p\Lambda^0 K^+\pi^+\pi^-\pi^+\pi^-\pi^+\pi^-\pi^+\pi^-\pi^+\pi^-. \quad (1)$$

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In this reaction Λ^0 is produced polarized, and this polarization is a function of x_F, P_T, and $M_{\Lambda^0 K^+}$.

This sample consists of fully reconstructed pp events at 27.5 GeV. All final-state particles are measured and identified. Two previous measurements have been published [5] of Λ^0 polarization from

$$pp \rightarrow p\Lambda^0 K^+ \pi^+ \pi^- \pi^+ \pi^- \pi^+ \pi^- \tag{2}$$

$$pp \rightarrow p\Lambda^0 K^+ (\pi^+ \pi^-)^N; N = 1,2,3,4. \tag{3}$$

at 27.5 GeV, together with one measurement [2] of

$$pp \rightarrow p\Lambda^0 K^+. \tag{4}$$

at 800 GeV.

2. The BNL 766 Experiment and Λ^0 Data

The data for this study were recorded at the Alternating Gradient Synchrotron (AGS) at Brookhaven National Laboratories in experiment E766, described in detail elsewhere [6]. For this study, 1973 Λ^0's satisfied the selection criteria reported elsewhere [6].

3. Λ^0 Polarization and Results

This study of Λ^0 polarization explores the dependence of the polarization on the kinematic variables P_T, x_F and $M_{\Lambda^0 K^+}$ in the final states represented by Eq. (1). The way these variables are defined and the way Λ^0 polarization is measured are explained elsewhere [5].

Λ^0 polarization has the same positive sign in both hemispheres $x_F > 0$ and $x_F < 0$, in contrast to Λ^0 polarization from the reactions of Eq. (2), which has opposite signs, negative in the $x_F > 0$ hemisphere and positive in the $x_F < 0$ one [2].

To improve the statistical power of the polarization measurements, Λ^0 polarizations from both hemispheres are summed directly. The results are shown in Figure 1, as a function of $M_{\Lambda^0 K^+}$. This Λ^0 polarization behaviour has been observed previously in other reactions [2]. A Monte Carlo analysis was used to study possible systematic effects, caused by finite acceptance and finite resolution, that might bias the Λ^0 polarization measurements. The Monte Carlo sample is generated with unpolarized Λ^0's using a model for reactions (1) that faithfully reproduces all kinematic distributions. This sample of events is subjected to the same analysis programs and cuts used for the data. The measured polarization for this Monte Carlo sample, which is generated with zero polarization, is found to be consistent with zero as a function of x_F, P_T, and $M_{\Lambda^0 K^+}$.

In a second analysis that makes a direct comparison with data, Monte Carlo events are weighted by $(1 + \alpha \wp \cos\theta)$ with $\wp$ measured, for each bin of $M_{\Lambda^0 K^+}$. The Λ^0 polarization in the Monte Carlo is in good agreement with the data, all the χ^2/dof between data and Monte Carlo distributions being close to 1. The $\cos\theta$ distributions are not quite linear, due to detector acceptance, and these acceptance induced variations in $\cos\theta$ are reproduced by the Monte Carlo.

Λ^0 polarization in reactions (1) depends on x_F, P_T, $M_{\Lambda^0 K^+}$; this polarization is similar to that determined in $pp \rightarrow p\Lambda^0 K^+$ at 800 GeV [2]. 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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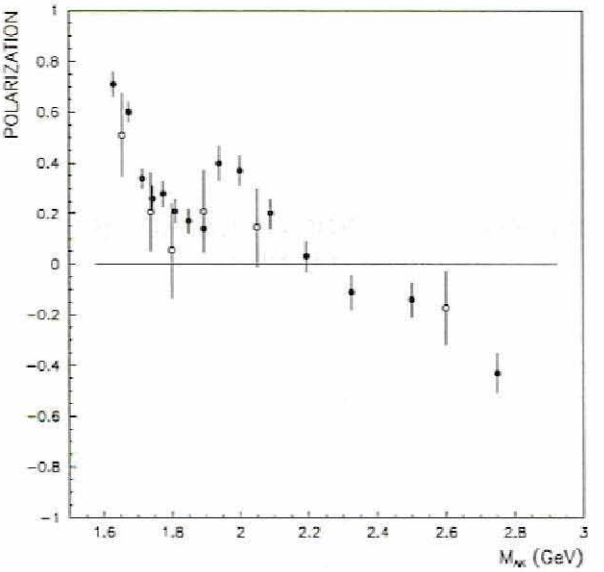

Fig. 1. Λ^0 Polarization as a function of the $M_{\Lambda^0 K^+}$ invariant mass. Open circles, this experiment; filled ones, Reference 2 (J. Félix *et al*).

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