Study of Excited Ξ Baryons in $\bar{\mathrm{p}}\mathrm{p}$-Collisions with $\overline{\mathrm{P}}\mathrm{ANDA}$

Authors:

Jennifer Pütz, Albrecht Gillitzer, James Ritman

Abstract

Understanding the excitation pattern of baryons is indispensable for a deep insight into the mechanism of non-perturbative QCD. Up to now only the nucleon excitation spectrum has been subject to systematic experimental studies while very little is known on excited states of double or triple strange baryons.
In studies of antiproton-proton collisions the $\overline{\mathrm{P}}$ANDA experiment is well-suited for a comprehensive baryon spectroscopy program in the multi-strange and charm sector. A large fraction of the inelastic $\bar{\mathrm{p}}\mathrm{p}$ cross section is associated to final states with a baryon-antibaryon pair together with additional mesons, giving access to excited states both in the baryon and the antibaryon sector.
In the present study we focus on excited Ξ states. For final states containing a $\Xi\,\bar{\Xi}$ pair cross sections up to the order of μb are expected, corresponding to production rates of $\sim 10^6$/d at a Luminosity $L = 10^{31}\,\mathrm{cm}^{-2}\,\mathrm{s}^{-1}$ (5% of the full value). A strategy to study the excitation spectrum of Ξ baryons in antiproton-proton collisions will be discussed. The reconstruction of reactions of the type $\bar{\mathrm{p}}\mathrm{p} \to \Xi^{*}\,\bar{\Xi}$ (and their charge conjugated) with the $\overline{\mathrm{P}}$ANDA detector will be presented based on a specific exemplary reaction and decay channel.

Contents

1 Motivation

2 Event generation

first key words!!!!

- parameter for evt generation table 2.1

Table 2.1: Parameter for event generation

Parameter	Value
Beam momentum	4.6 GeV/c^2
Production	PHSP
Tracking	Ideal
Particle ID	Ideal

- beam momentum: 100 MeV over threshold
- assumed: highest cross section (Quelle!!!!!!)
- Software Framework: Pandaroot 2.2

Table 2.2: Used software versions

Software	Version
FairSoft	mar15
FairRoot	v-15.03a
PandaRoot	trunk revision 28555
Geant	3
Genfit	1

- for signal: 1.5 Mio events
- decay channel shown in picture 2.1
- add particle to evt.pdl (code sniplet 2.1 with values table 2.3 from [1] (Source!!!!)

Listing 2.1: sniplet from evt.pdl

Table 2.3: Values for $\Xi(1820)^-$ and $\bar{\Xi}(1820)$ from [1]

Particle	J	I	P	Charge	Mass	Width
$\Xi(1820)^-$	$\frac{3}{2}$	$\frac{1}{2}$	(-1)	(-1)	(1.823 ± 5)GeV/c^2	(0.024 ± 6) GeV
$\bar{\Xi}(1820)$	$\frac{3}{2}$	$\frac{1}{2}$	(-1)	1	(1.823 ± 5)GeV/c^2	(0.024 ± 6) GeV

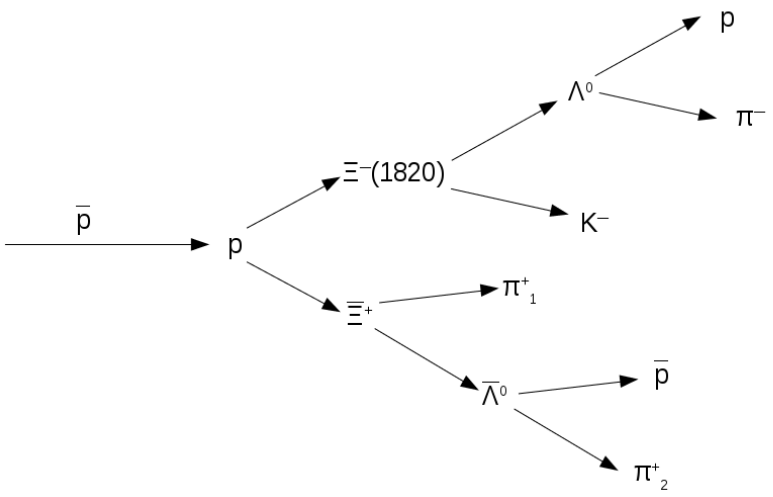

Figure 2.1: Simulated decay channel

```
add  p Particle Xi(1820)- 23314 1.8230000e+00 2.4000000e-02
   2.0000000e-01 -3 3 0.0000000e+00 23314
add  p Particle anti-Xi(1820)+ -23314 1.8230000e+00 2.4000000e-02
    2.0000000e-01 3 3 0.0000000e+00 -23314
```

3 Analysis

Here is all the stuff of the analysis!

3.1 Final state particle

-final state particle: proton, antiproton, π^-, π^+, K^- and K^+ mesons -reconstructed in Detector -only particles with more then 3 hits either in one of the subdetectors (reason: 3 hits define circle; fourth hit point gives a validation for track hypothesis) - ideal PID (reason!!!)

-reco efficiency in table 3.1

3.2 Reconstruction of Λ^0 and $\bar{\Lambda}^0$

3.2.1 Combination

-only final state particle with more than 3 Hits

-daughter particles for Λ^0: proton an π^- meson

-daughter particles for $\bar{\Lambda}^0$: $\bar{p}$ and π^+ here π^+ 2

-fitting daughters to common point using kinematic vertex fitter

-using mass fitter with input of vertex fitter

-only select particles with prob bigger than 0.01 for both fitter

-scheme in figure 3.2

-if there is more than one particle choose best candidate to go on

Figure 3.1: The plot is showing the number of reconstructed particles...

Table 3.1: reco efficiency and momentum resolution

final state	N/%	$\frac{\sigma p}{p}$/%
π^-		
π_1^+ $(\bar{\Xi})$		
π_2^+ $(\bar{\Lambda}^0)$		
K^-		
p		
$\bar{p}$		

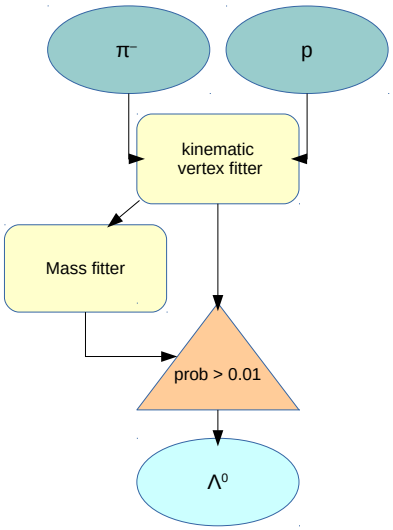

Figure 3.2: Scheme for Lambda0 reconstruction

4 Background

Bibliography

[1] J. B. et al., *Particle Data Group.* Phys. Rev. D86, 010001, 2012.