$\Lambda\ \bar{\Lambda}$ Spin Correlations

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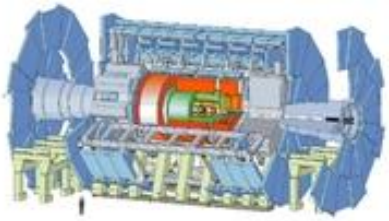
the ATLAS Experiment



Analysis Overview

- We are looking for **spin correlations** between hyperons produced in high energy collisions
  - Specifically, we are looking at $\Lambda\,\bar{\Lambda}$ pairs where

$$p + p \rightarrow \Lambda + \bar{\Lambda} + X$$

$$\Lambda \rightarrow p\,\pi^- \text{ and } \bar{\Lambda} \rightarrow \bar{p}\,\pi^+$$

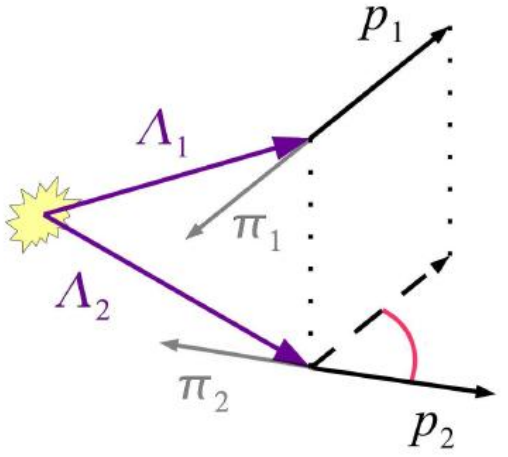
- Hyperon production is not well understood
  - We want to know if $\Lambda\,\bar{\Lambda}$ pairs come from the same $s\bar{s}$ pair produced in the vacuum
  - A correlation between the spins would support the idea that the Λ and $\bar{\Lambda}$ come from the same $s\bar{s}$ pair

Analysis Method

- We know that the **angular distribution** of the $\Lambda/\bar{\Lambda}$ daughter $p/\bar{p}$ in the $\Lambda/\bar{\Lambda}$ rest frame depends on the **spin** of the $\Lambda/\bar{\Lambda}$
- It can be shown that **y* distribution** that we observe is given by

$$dN/dy^*_{observed} = \epsilon \times dN/dy^*_{real}$$

$$dN/dy^*_{real}\ \alpha\ 1 - \boldsymbol{a}\ \alpha^2_\Lambda\ y^*$$



  - **y*** is the cosine of the angle between the $p/\bar{p}$ in the $\Lambda/\bar{\Lambda}$ rest frame
- We want to measure the asymmetry **a**

$$\boldsymbol{a} = \frac{N_{aligned} - N_{antialigned}}{N_{total}}$$

$$aligned \Longrightarrow \uparrow\uparrow \text{ or } \downarrow\downarrow$$

$$anti\text{-}aligned \Longrightarrow \uparrow\downarrow \text{ or } \downarrow\uparrow$$

  - We can measure **a** by studying the y* distribution
  - **a** = 1 => full correlation

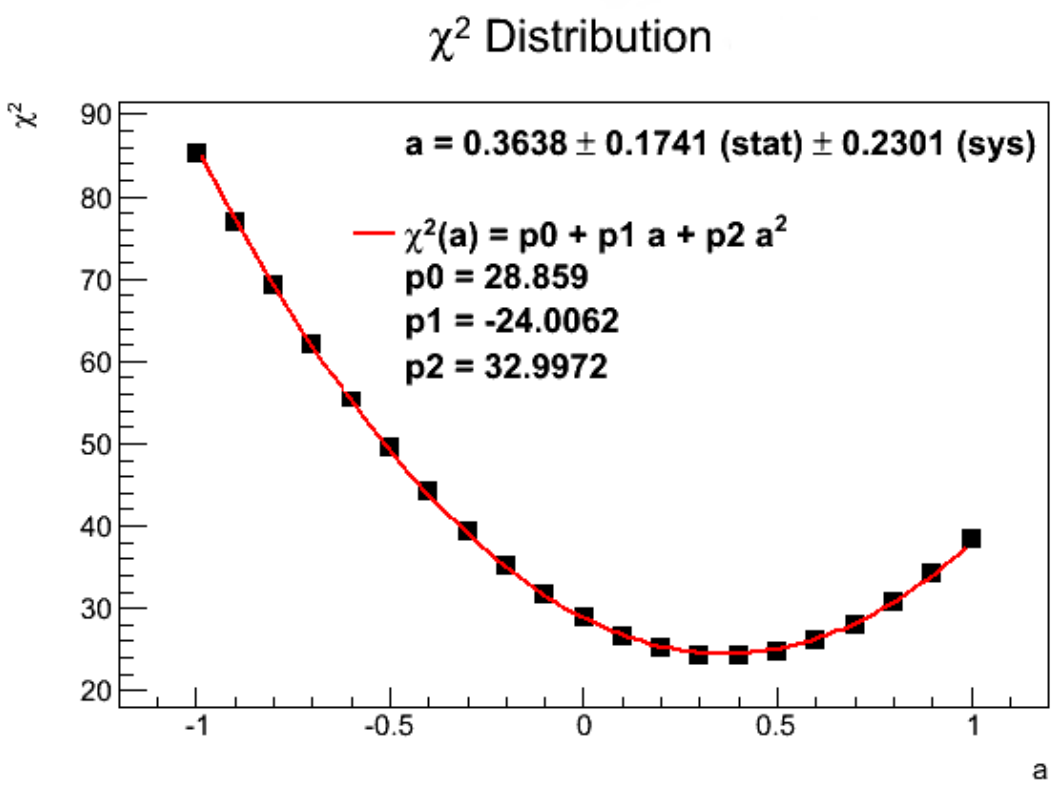
    a = -1 => full anti-correlation

    a = 0 => no correlation

Diagram: Measurement of ΛΛ spin correlations in the SELEX experiment A A Savchenko et al 2011 J. Phys.: Conf. Ser. 295 012089

Fitting

- We know that **a** = 0 in our MC
  - => $dN/dy^*_{observed\ (MC)}$ α ε
  - => Multiplying the MC distribution by dN/dy^*_{real} (**a**) creates a template with the theoretical distribution for that value of **a**
- To fit, we compare each template to data and calculate the χ^2
- Smallest χ^2 => best fit value for **a**



Conclusions

- We currently see **some asymmetry** in data
- Still studying systematic uncertainties
- Possible issues:
  - Low statistics in both MC and data
    - But beginning to look at 2011 MC/data
    - Will be writing a toy MC to validate analysis
  - MC doesn't describe data perfectly
    - Is the difference due only to the asymmetry that is not modeled in MC, or are there other effects?
    - Toy MC will help us understand this as well