

DOUBLY CHARMED BARYONS

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Abstract

Candidates for several new high-mass states which include a cleanly-identified daughter Λ_c^+ baryon are seen in data from the SELEX experiment at Fermilab. These states are candidates for doubly charmed baryons: a Ξ_{cc}^{++} state and a Ξ_{cc}^+ state. These candidates are more than 5σ signals in each case at masses of 3520 and 3460 MeV respectively.

1. INTRODUCTION

The SELEX experiment, of which I am a spokesman, reports evidence for three new high-mass states decaying into $\Lambda_c^+ K^- \pi^+$ (π^+). These states are consistent with some expectations of the doubly charmed baryons predicted by the broken SU(4) symmetry of a system with four quark flavors [1]. This work is presently being published in the refereed journals with one paper already in print [2] and others in preparation. I shall only briefly summarize this work here.

2. DOUBLY CHARMED BARYON CANDIDATES FROM SELEX

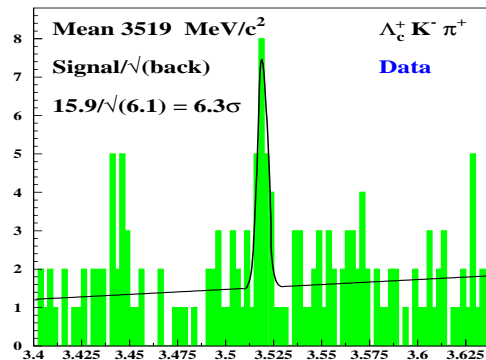


Fig. 1: SELEX Ξ_{cc}^+ (3519) signal.

SELEX reports [2] a Ξ_{cc}^+ state at 3519 MeV with a statistical significance of 6.3σ (Figure 1) and an apparent iso-partner Ξ_{cc}^{++} state at 3460 MeV with a statistical significance of 4.8σ (Figure 2). Both of these states have a width consistent with resolution and a very short lifetime (<30 fs). SELEX also sees a broad state at 3783 MeV (Figure 3) which looks like a Ξ_{cc}^{*++} with evidence for the strong decay mode $\Xi_{cc}^{*++}(3783) \rightarrow \Xi_{cc}^+(3519)\pi^+$.

The FOCUS experiment has shown [3] their search for states like SELEX observes. Starting with 10 times more Λ_c^+ events they have no evidence for any signals, and few entries in general, in a long list of decay modes, including those where SELEX sees signals. Whatever SELEX observes in hadro-production with baryon beams is not observed in photo-production.

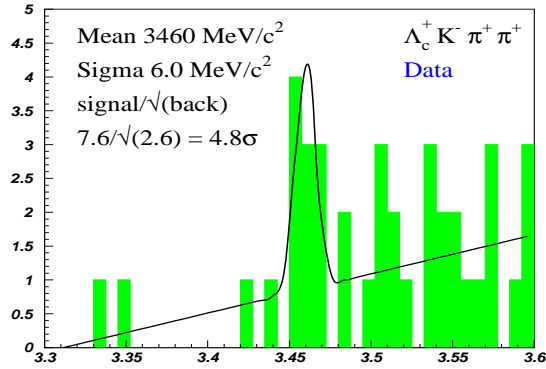


Fig. 2: SELEX $\Xi_{cc}^{++}(3460)$ signal.

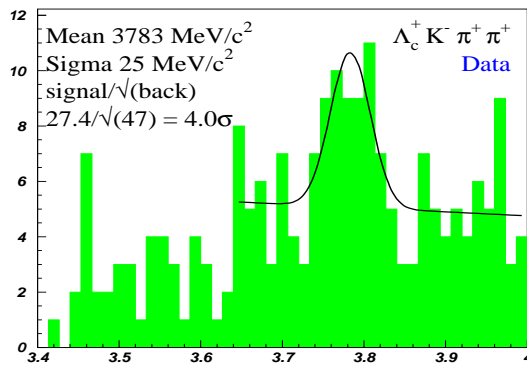


Fig. 3: SELEX $\Xi_{cc}^{*++}(3783)$ signal.

The SELEX signals do not constitute a clear and unambiguous picture as doubly charmed baryons. The production cross-section of these states, in the forward region where SELEX is sensitive, is considerably higher than expected; lifetimes as short as 30 fs are less than models predict and a 60 MeV mass difference between $\Xi_{cc}^+(3519)$ and $\Xi_{cc}^{++}(3460)$ is hard to understand as an isospin splitting. With evidence for three inter-related new states we can only guess, at this time, what fraction and pieces of the total picture we are now seeing.

What is abundantly clear it that these signals are not statistical fluctuations; they are something. The only alternative interpretation consistent with the observed properties of these states is as decays of very high mass, singly charmed baryon excited states with absurdly narrow strong decay widths.

3. FUTURE PROSPECTS

We can look forward to further measurements from SELEX, and hopefully others, to confirm (or contradict) these signals. New work on the phenomenology and models of doubly charmed baryons can also be expected in order to more fully understand these observations.

References

- [1] Particle Data Group, K. Hagiwara *et al.*, Phys. Rev. D **66** (2002) 010001.
- [2] SELEX Collaboration, M. Mattson *et al.*, Phys. Rev. Lett. **89** (2002) 112001.
- [3] FOCUS Collaboration, S. Ratti, Proceedings of the 5th International Conference on Hyperons, Charm, and Beauty Hadrons, Vancouver, BC, Canada, 25–29 July 2002.