CHARMED BARYON PRODUCTION IN FNAL HYPERON BEAM

(Project of experiment E781)

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The present knowledge of charmed baryons remains sketchy, and it concerns mostly hadronic production and the decay of Λ_c^+(udc). In 1980 an observation of Ξ_c^+(usc) was reported by the WA62 experiment [1] performed in the CERN hyperon beam at 135 GeV/c. This baryon state was observed through the decay channel $\Lambda K^-\pi^+\pi^-$. A remarkable feature of this observation was the large cross-section at large x, 1 μb at x>0.6, that might be a manifestation of the leading particle effect. WA62 reported also a hint of the Ω_c(ssc) based on three events close to 2.74 GeV.

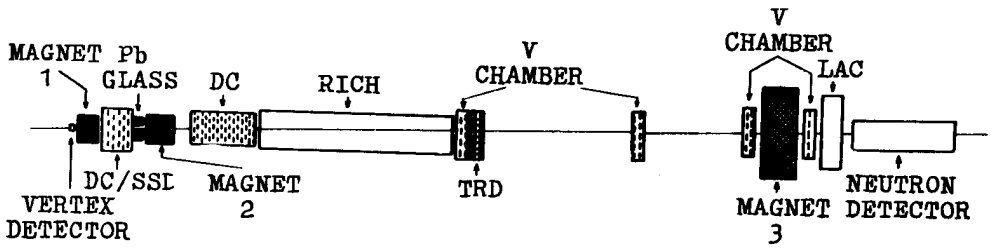

Fig. Layout of baryon spectrometer. DC — drift chambers, SSD — Si — strip detector, Pb glass — electromagnetic calorimeter, RICH — Cherenkov counter, V Chamber — drift chambers of V-spectrometer, LAC — liquid-argon calorimeter

The hyperon beam at FNAL is much more abundant than that used is WA62. There should be $10^6\Sigma^-$/s in the 600 GeV/c beam with a 50/50 Σ/π ratio. Any charm mode with 1 μb cross section within the acceptance of the experiment, yields approximately 10^6 detected events in the 16 week running period. For comparison WA62 has detected only 100 Ξ_c^+ events. Similarly, one should expect about 30000 events of Ω_c as compared to 3 events in WA62.

An additional advantage of the high energy beam is the large value of the Lorentz boost factor. This makes it easier to isolate the decay vertices and to measure the lifetimes of the charmed baryons. Also, it helps to collect within the acceptance of the spectrometer all the decay prongs from the charmed baryons and the decay photons from the excited charmed baryon states.

Large-x baryon spectrometer [2]

The layout of the proposed spectrometer is shown in the figure. The 600 GeV/c beam hits the 'active target' (vertex detector). The vertex detector consists of several 25 μm pitch SSD-planes

interspaced by 5 mm. This should isolate the secondary decay vertex from the primary even for lifetimes as short as 0.1 ps. An important part of the vertex detector is the silicon pixel detector (30 μm x 30 μm pixels) that should help to reconstruct multiprong events.

The system consisting of a vertex detector, magnet 1, and a set of drift chambers serves as a Slow Particle Spectrometer. The central region in the drift chambers is deadened to allow the primary beam to go through, and this region is covered by 50μm pitch SSDs. The baryons produced by the heavy flavor decays (Λ, p, Σ, Ξ) have small angles, of the order of 10 mrad. The momentum range is 100-400 GeV/c. These tracks should be analyzed by a Fast Particle Spectrometer (magnet 2, drift chambers) followed by a VEE Decay Spectrometer (magnet 3, drift chambers).

$p/K/\pi$ identification will be done by using RICH counters. Electron identification could be performed with gamma calorimeters and also with a TRD. Forward gammas will be detected with a liquid argon calorimeter, while a Pb glass detector will cover a wider angular range. Neutron detection is also foreseen by using an iron/scintillator calorimeter.

Physics objectives

The main feature of the proposed large-x baryon spectrometer is the high efficiency for detection and identification of all the decay products of a heavy-flavor baryon with $x \geqslant 0.3$, combined with clear isolation of the decay vertices. This determines the physical program:

A. Search for new baryon states:
   (ddc), (ssc), (ucc), (udb), etc.
B. Search for charmed baryons excited states:
   (udc)*, (usc)*, etc.
C. Measurement of branching ratios for charmed baryons into various final states, (Σ, Ξ, Λ, or nucleon).
D. Study of the charmed baryon semi-leptonic decay.
E. Charmed baryon lifetime measurements.
F. Search for Exotic States (other than qq or qqq systems).
G. Study of the charm production mechanism.

The experiment should be prepared for running in 1993.

REFERENCES

1. *Biagi S. F. et al.* Phys. Lett. 1983. 122B. 455.;
   Phys. Lett. 1985. 150B. 230.
2. Fnal Proposal P781. November 8. 1987.