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CHARM STRANGE BARYONS AND THE 1.5 PRONG

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The charm strange baryons, Ξ_c^0 , Ξ_c^+ , and Ω_c^0 , are most reliably tagged as baryons by their decay into charged hyperons. Six of the nine decay modes of these charm strange baryons, which have currently been observed (Table 1), exhibit such decays. The charged hyperon travels about a meter with wide variations (Table 4). This can give rise to a track which is seen in the silicon microstrip detector (SMD) but not further downstream. To use the charged hyperon to form a vertex, the silicon microstrip stub must be found. In two out of four of the observed decays of the Ξ_c^0 the stub must be combined together with only one other track to form a vertex; hence the title *1.5 prong*. A real 2-prong is not available for a topological vertexer to find. A topological vertexer also misses $\Xi_c^+ \rightarrow \Xi^- \pi^+ \pi^+$ because it appears to be a 2-prong with charge = +2. The short lifetimes of charm strange baryons again hamper a plain topological vertex filter.

But all is not lost. Many of the hyperons, which are relatively rare in normal events but common in charm strange baryon events, decay into a Λ . This and perhaps other tags can be used to supplement a vertex filter. These Λ s will appear to have an unusually long lifetime, because they have originated from a hyperon decay downstream of the target. This is a further tag that they have indeed come from a hyperon decay. It may also be possible to find and filter hyperons which do not decay into Λ s with adequate efficiency to determine charm strange baryon branching ratios involving them. That is the good news. The bad news is that the Λ s often decay in the first E791 analyzing magnet and techniques must be optimized to find and filter on these long-lived Λ s. Those that decay downstream of D2 cannot be completely momentum analyzed. A few charged hyperons will make it into D2 allowing direct momentum measurement; but in these cases not much decay space is left for a Λ .

In summary, new filtering techniques must be developed in addition to a topological vertex filter to adequately exploit charm strange baryons. This work was supported by the U.S. Department of Energy (DE-FG05-91ER40622).

Table 1. Charm Strange Baryon Decay Modes

Observed	Unobserved (Partial List)
$\Xi_c^0 \rightarrow \Xi^- \pi^+$	$\Xi_c^0 \rightarrow \Lambda K_S^0$
$\Xi_c^0 \rightarrow \Xi^- \pi^+ \pi^+ \pi^-$	$\Xi_c^0 \rightarrow \Xi^- e^+ \nu_e$
$\Xi_c^0 \rightarrow p K^- \bar{K}^*(892)^0$	$\Xi_c^0 \rightarrow \Xi^- \mu^+ \nu_\mu$
$\Xi_c^0 \rightarrow \Omega^- K^+$	$\Xi_c^0 \rightarrow \Sigma^- K^- \pi^+ \pi^+$
	$\Xi_c^0 \rightarrow \Xi^0 \phi$
$\Xi_c^+ \rightarrow \Lambda K^- \pi^+ \pi^+$	$\Xi_c^+ \rightarrow \Lambda K_S^0 \pi^+$
$\Xi_c^+ \rightarrow \Sigma^+ K^- \pi^+$	$\Xi_c^+ \rightarrow \Xi^- \pi^+ e^+ \nu_e$
$\Xi_c^+ \rightarrow \Sigma^0 K^- \pi^+ \pi^+$	$\Xi_c^+ \rightarrow \Xi^- \pi^+ \mu^+ \nu_\mu$
$\Xi_c^+ \rightarrow \Xi^- \pi^+ \pi^+$	
$\Omega_c^0 \rightarrow \Xi^- K^- \pi^+ \pi^+$	$\Omega_c^0 \rightarrow \Omega^- \pi^+$
	$\Omega_c^0 \rightarrow \Omega^- e^+ \nu_e$
	$\Omega_c^0 \rightarrow \Omega^- \mu^+ \nu_\mu$

Table 2. Branching Ratios of Decay Products

Particle	Decay Mode	%
K_S^0	$\pi^+ \pi^-$	68.6
$\bar{K}^*(892)^0$	$K^- \pi^+$	67
ϕ	$K^+ K^-$	49.1
Λ	$p \pi^-$	64.1
Σ^-	$n \pi^-$	99.8
Σ^0	$\Lambda \gamma$	100
Σ^+	$p \pi^0$	51.6
	$n \pi^+$	48.3
Ξ^-	$\Lambda \pi^-$	100
Ξ^0	$\Lambda \pi^0$	100
Ω^-	ΛK^-	67.8
	$\Xi^0 \pi^-$	23.6

Table 3. E791 Spectrometer Z Locations

	Z (cm)
First Target	-8.2
Last Target	-2.1
First SMD	0.7
Last SMD	45.5
PWC #9	118.5
First D1 Plane	142.5
Last D1 Plane	183.6
Middle of Magnet 1	272.2
First D2 Plane	382.4
Last D2 Plane	500.9

Table 4. Decay Lengths of Weakly Decaying Particles for 3 Momenta

Particle	Quarks	Mass (MeV/c ²)	$c\tau$ (cm)	20 GeV/c (cm)	50 GeV/c (cm)	100 GeV/c (cm)
Ω_c^0	ssc	2719.				
Ξ_c^0	dsc	2472.7	.0025	.02	.05	.10
Ξ_c^+	usc	2466.4	.0090	.07	.18	.36
Λ_c^+	udc	2284.9	.0057	.05	.12	.25
D^0	$c\bar{u}$	1864.5	.0126	.14	.34	.68
D_s^+	$c\bar{s}$	1968.8	.0135	.14	.34	.69
D^+	$c\bar{d}$	1869.3	.0320	.34	.86	1.71
$\bar{B}^0$	$b\bar{d}$	5278.7	.0387	.15	.37	.73
B^-	$b\bar{u}$	5278.6	.0387	.15	.37	.73
$\bar{K}^0$	$s\bar{d}$	497.7	K_S^0 2.68	108	269	538
Λ	uds	1115.6	7.89	141	354	707
Σ^-	dds	1197.4	4.43	74	185	370
Σ^+	uus	1189.4	2.39	40	100	201
Ξ^-	dss	1321.3	4.91	74	186	372
Ξ^0	uss	1314.9	8.69	132	330	661
Ω^-	sss	1672.4	2.46	29	74	147

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