TAGGED HIGH ENERGY $\bar{n}$, HYPERON AND ANTI-HYPERON BEAMS AT NAL

David Cline
University of Wisconsin

August 12, 1968

With the advent of high-energy high-intensity accelerators it becomes reasonable to discuss the production of relatively high-energy exotic beams. In particular the availability of nearly monochromatic Λ and $\bar{\Lambda}$ beams would open up a new class of hadron interactions (i.e. the comparison of Λp and $\bar{\Lambda} p$ total cross sections at high energy; $I = 1$ meson exchange being forbidden for these processes might lead to equal cross sections at a lower momentum than for $\bar{p}p$ and pp). In addition, it should be possible to obtain high-intensity partially separated $\bar{p}$ beams (~ 10^6/pulse with 10 - 40 BeV/c) at the thin target stations. Using these beams, it should be possible to obtain adequate $\bar{n}$ or $\bar{\Lambda}$ beams for counter, streamer-chamber or rapid-cycling bubble-chamber experiments.

Although it seems possible to obtain high-energy Σ^- beams using the highest energy negative particles coming from a target, the production of Λ, $\bar{\Lambda}$ and $\bar{n}$ beams is intrinsically more difficult.

One possible technique is to use the characteristic properties of the diffraction dissociation processes to produce fast Λ, $\bar{\Lambda}$ and $\bar{n}$'s with these processes being tagged using mesons produced in the dissociation process. The processes to be used are

$$p + A \to N^*(1400) + A$$
$$\qquad \hookrightarrow n + \pi^+$$

$$\bar{p} + A \to \bar{N}^*(1400) + A$$
$$\qquad \hookrightarrow \bar{n} + \pi^-$$

$$p + A \to N^{*+}(1700) + A$$
$$\qquad \hookrightarrow \Lambda + K^+$$

$$\bar{p} + A \to \bar{N}^*(1700) + A$$
$$\qquad \hookrightarrow \bar{\Lambda} + K^- ,$$

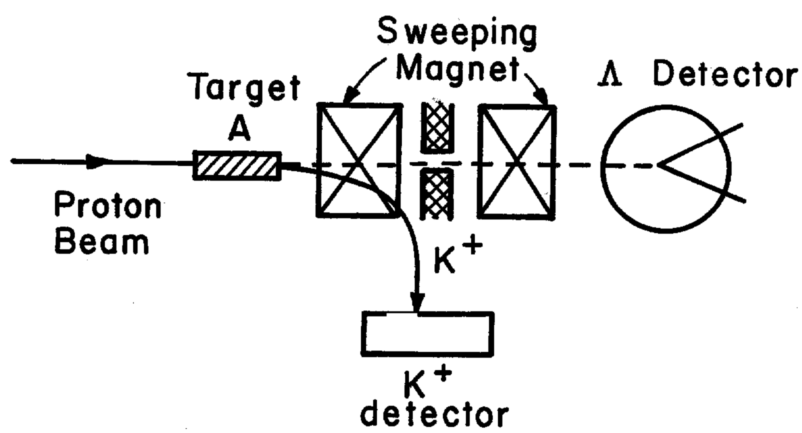
with A being a nucleus of atomic number A. The characteristic features of these process are

1. The N^*'s are produced strongly forward on protons and should be even more sharply forward on nuclei A. The baryons from the N^* decay carry essentially all the beam momentum.
2. The $N^* \to \pi n$, $\to \Lambda K$ is most likely isotropic in the center of mass.
3. The cross section for N^* (1400) [and possibly N^* (1700)] is substantially larger than that either of charge exchange or for other N^* production with incident nucleons above a momentum of ~ 10 BeV/c. [At low momentum the production of Δ (1238) is large.]
4. The cross section for these N^* production is presumably almost constant with energy.
5. The decay of N^* (1700) $\to \Lambda K$ might give polarized Λ's at certain angles in the N^* center of mass.

Unfortunately, only fragmentary experimental evidence exists concerning the N^* (1700) production and even less information is available concerning the ΛK decay of this object. However, there exists some evidence that the reaction $\pi^- p \rightarrow \Lambda K$ couples strongly to an N^* with mass in the 1700 region. In addition $pp \rightarrow \Lambda K p$ experiments below 8 BeV/c see a strong accumulation of ΛK events near 1700 with a low momentum transfer to the nucleon.

It would be extremely useful if experiments were performed at the AGS to measure the Λ flux associated with a K^+ using high energy protons.

The scheme for making such a beam is shown below.



If the N^* (1700) production followed by a subsequent decay into ΛK^+ does dominate the N^* production process for very high momentum p' s, then a crude momentum measurement of the K^+ (~ 20%) should define the Λ momentum to much better than 20%. Using the same set up but with incident $\bar{p}$'s and tagging outgoing π^- should provide an $\bar{n}$ beam of relatively high intensity (i.e. at 10 BeV/c with 10^6 $\bar{p}$/pulse, ~ 10^2 - 10^3 $\bar{n}$ might be obtained in a small solid angle). If the outgoing baryon momentum from the N^* decay is strongly correlated to the pion or kaon momentum it might be possible to use a larger solid angle hyperon or $\bar{n}$ beam. The $\bar{\Lambda}$ flux available by such techniques would surely be one to two orders of magnitude down from the $\bar{n}$ flux.

Finally, using a monochromatic neutron beam with the same device it should be possible to make tagged Σ^- beams using the process

$$n + A \rightarrow N^{*o}(1700) + A$$
$$\hookrightarrow \Sigma^- K^+.$$

In this case, the first sweeping magnet is used to deflect the Σ^- through the hole in the shielding wall. Some further momentum analysis could be used beyond the hole.