REPORT FROM THE HYPERON PHYSICS SUBGROUP

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ABSTRACT

A number of topics were considered in the Hyperon Group. As the time was reasonably short, and the group was not large, the list of topics is by no means exhaustive. The topics discussed should rather be considered a sampling of a much more extensive list of topics that might have been discussed. This report will thus consist of some brief remarks relevant to the topics discussed, and a few concluding remarks. The interested reader is referred to the references for appropriate details.

RIGHT-HANDED CURRENTS?

The standard picture of weak interactions is based on left-handed currents, i.e., a pure V-A structure. It is appropriate to ask to what extent may right-handed currents be ruled out. Beg[1] et al. in 1977 suggested that the V+A current terms could be as large as 13% of the V-A terms! More recently, Bigi and Frere[2] have suggested that one may set stringent limits on $\sin\xi$, the amount of right-handed charged current mixing in $\Delta I = 3/2$ non-leptonic hyperon decays, by studying this $\Delta I = 3/2$ component of weak hadronic hyperon decays alone. In these decays, there is a strong enhancement of a left-right interference term leading to much improved sensitivity to right-handed currents. Bigi and Frere determined $|\sin\xi| < 0.01$ as an upper bound.

The question of right-handed current effects in semileptonic decays has also been addressed.[3] It was pointed out that the long-standing discrepancies between the value of g_1/f_1 obtained from spin asymmetry measurements and Dalitz plot measurements in $\Lambda \to pe\nu$ can be resolved by the inclusion of significant amounts of right-handed current. In fact, the fits presented in Reference 3 suggest a right-handed component in the $\Delta S = 1$ current of almost 30%! It might be concluded that additional clarification of this fundamental question in theoretical and/or experimental regimes is sorely needed.

RARE HYPERON DECAYS, INCLUDING γ DECAYS

It must be clearly stated at the outset when discussing rare hyperon decays that data is woefully meager at best![4] First, consider the radiative decays. Excluding $\Sigma^0 \to \Lambda\gamma$, there are only two branching ratios: $\Sigma^+ \to p\gamma$ $(1.2 \pm .13) \times 10^{-3}$, and $\Xi^0 \to \Lambda\gamma$ $(5\pm0.5)\times10^{-3}$, and one asymmetry, $\alpha_{\Sigma p\gamma} = -.72 \pm .29$, that have been measured. There are also limits on $\Xi^0 \to \Sigma^0\gamma$ and $\Xi^- \to \Sigma^-\gamma$ (< 0.07, $< 1.2 \times 10^{-3}$ respectively).

There are three obvious diagrams that can contribute: a) single quark, b) two quark and c) three quark diagrams.[5] The data are inconsistent with the most simple assumption that baryon radiative decay proceeds exclusively via a single quark diagram. A somewhat more ambitious model including single and double quark diagrams can fit all of the (meager!) data. It is abundantly clear that in the area of radiative decays, data is certainly lacking.

One might also test invariance principles and conservation laws by looking for forbidden hyperon decays. For example, $\Delta S > 1$ transitions might be looked for by searching for $\Xi^0 \to p\pi^-$. Naively, one might expect the branching ratio to be $\sim 10^{-10}$. The current limit[4] is $< 3.6 \times 10^{-5}$. 10^{-10} seems very hard indeed! Other models such as $\Xi^- \to ne^-\nu$ and $n\mu^-\nu$ have also been sought, but the limits are not as stringent as for $\Xi^0 \to p\pi^-$. The study of Ω^- decays presents the opportunity to search for $\Delta S = 3$ decays! Of course, in the context of the standard models, a decay such as $\Omega^- \to n\pi^-$ would be most unlikely.

Searches for $\Sigma^+ \to p^+e^-e^-$, $\Sigma^+ \to p^+\mu^\pm e$, ... or $\Sigma^+ \to ne^+\nu$, ... to search for family, lepton number, or $\Delta S = \Delta Q$ violation must also be pursued to more constraining levels.

HYPERON BETA DECAY

Recent fits to the hyperon semileptonic decay rates and the value of g_1/f_1 may, if $\Sigma^- \to \Lambda e^-\nu$ is excluded, be well fit to an extended Cabibbo hypothesis with some SU(3) breaking[6], (extended in the Kobayashi-Maskawa sense.) It must be noted however, that except for n and Λ beta decays, the data input to the fits are only determined to $\sim 10\%$, or worse. Rates for only two muon modes ($\Lambda \to p\mu^-\nu$, $\Sigma^- \to n\mu^-\nu$) have been determined. It might be guessed that were there tighter constraints from the data, the business of doing "Cabibbo fits" would become very demanding. This guess is supported by recent efforts at doing detailed fits to $\Lambda \to pe\nu$ decays.[7] In these fits, it is found that the values of the form factors obtained depend, for example, on the form of q^2-dependence assumed.

Further, one finds that it is possible to calculate form factors within the context of the quark model or the bag model.[8] These form factors may be used as some of the input to fits when equivalent data are not available. Including the calculated value of the form factor g_2 (weak electric form factor), induces substantial changes in g_1 (axial vector form factor). It thus becomes clear that the high precision hyperon experiments are no longer simply weak interaction experiments, but are, in fact, experiments that probe the details of hadron structure.

CONCLUSION

The area of hyperon physics continues to be a rich field of study for theorists and experimentalists alike. As the experiments improve, the field of hyperon physics expands out of its traditional role as a testing ground for the Cabibbo theory of weak interactions and into the much fuller role of probing the details of hadron structure as well as providing a testing ground for the standard electroweak model. This expanded role is seen in each of the areas mentioned above. It is to be expected that the future of hyperon physics will continue to be both challenging and exciting.

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