Fermilab Proposal No. 364

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A Proposal to Search for Charmed Particles Originating from the Interactions of 400 GeV/c Protons in Emulsion Nuclei

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INTRODUCTION

There has been much recent discussion of the possibility of the existence of 'charmed' particles, hadrons which possess non-zero values of 'charm'[1], a further additive quantum number. These particles may be generated either in the three triplet model of Han and Nambu[2] or by the postulate of a fourth, charm-bearing quark[3].

On the assumption that charm, like strangeness, is conserved in strong and electromagnetic interactions (the opposite assumption would necessitate charmed particles coupling strongly to ordinary hadrons and the existence of yet undiscovered states, e.g. Z^*s) but not conserved in weak interactions one might expect their production either singly in neutrino interactions or in pairs in associated production in high energy hadron collisions, to be followed by their subsequent, relatively slow, decay into 'uncharmed' particles.

Various estimates as to mass, lifetime, production cross-sections and decay modes have been made for these particles[4]. However their failure to appear as di-lepton events among the neutrino interactions of the Brookhaven A.G.S. and CERN P.S. experiments might suggest that their masses are in excess of 2 GeV/c^2. On the other hand, such particles would have been expected to have been observed directly in bubble chamber studies at FNAL had their lifetimes been greater than 10^{-11}s as suggested by some authors.

This proposal, which may be thought of as complementary to that of Burhop et al[5], is for a straightforward exposure of a stack of emulsions to a 400 GeV/c proton beam to look for evidence of the pair production of charmed particles. The spatial resolution of the emulsion technique is about one micron with the consequence that the decays of particles of mean lives in the range 10^{-11} to 10^{-14}s should be readily observable.

EXPERIMENTAL ARRANGEMENT AND PROCEDURE

It is proposed to irradiate a stack of Ilford K5 emulsion pellicles of dimensions 7 x 15 x 10 cm^3 to a beam of 400 GeV/c protons over an area of 9 x 12 cm^2 as shown in fig. 1. On the assumption that the mean free path of 400 GeV/c protons in emulsion is $\sim$35 cm an exposure of 3.5×10^7 protons spread reasonably uniformly over the 9 x 12 cm^2 area will provide about one interaction of a primary proton/mm^2 in each of 160, 600 μm thick, pellicles over an area of 5 x 12 cm^2 - i.e. a total of 10^6 interactions. The reason for restricting the scanning to the front 5 cm of the stack facing the proton beam is to obviate the necessity to scrutinize too many stars formed by secondary particles.

The scanning will consist of area scanning for primary proton interactions and then looking for scatterings, interactions and neutral particle decays within a short distance (~100 μm or possibly a little more) from the primary vertex. The observation of charmed particles (or any other suitably ephemeral particles) would consist in establishing an excess of events (for charmed particles, presumably occuring in pairs) at short range over and above those to be expected from background sources. Most backgrounds (e.g. scatterings, interactions, hyperon, anti-hyperon decays, electron pairs) would be expected to occur with much longer characteristic lengths than a few hundred microns. The only known exception would be Dalitz pairs which at these primary energies would be expected to occur at distances typically tens of microns from the production vertex. However it is possible with some effort, even with a relatively small block of emulsion, to establish that such tracks are due to electrons.

From previous experience in hypernuclear decay studies, it is to be expected that a scanner may find and study in this way from 200 to 500 interactions per day. Thus the location and analysis of some million interactions should take between 2000 and 5000 scanner days - i.e. an experiment of one to two years' duration for a team of 10 scanners.

It is fair to point out that such an experiment was advocated by Snow[4] but sobering to remember that no such objects have come to light in previous emulsion studies of the cosmic radiation.

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REFERENCES

(1) BJORKEN and GLASHOW Phys. Lett. 11 (1964) 225

(2) HAN and NAMBU Phys. Rev. 139 (1965) B1006

(3) GLASHOW et al. Phys. Rev. D2 (1970) 1285

(4) e.g. PATI and WOO Phys. Rev. D3 (1971) 1173
SNOW Nucl. Phys. B55 (1973) 445
GAILLARD N.A.L. Conf. Report 74/43 THY (1974)

(5) BURHOP et al. FNAL experiment proposal 247

Fig. 1

Proposed emulsion stack.