Fermilab Proposal No. 430

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Proposal to Search for New Short-Lived Particles in 400 GeV/c $\pi^- p$ Interactions

Aachen-Bonn-CERN-London Collaboration

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SUMMARY

It is proposed to search for new short-lived particles of lifetimes $\sim 10^{-10}$ to 10^{-12} seconds in 50,000 photographs taken in the 15-foot hydrogen bubble chamber with a π^- beam of the highest available energy ($\approx$ 390 GeV).

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1. PHYSICS MOTIVATION

Recent discoveries of new particles in the 3 to 4 GeV mass range and of cascade decays between them, give considerable support to models such as that of Charm, which predict that there should exist particles D or F of mass $\gtrsim$ 2 GeV. Further it is predicted that these particles should have lifetimes in the range 10^{-11} to 10^{-13} seconds. If this is so, then by producing them with beams of sufficiently high energy, such particles, when neutral, may be visible as V^o decays in a bubble chamber. The optimum requirements are (1) that the incident energy be as high as possible so that their production cross section be large (2) that the D particles be of the greatest possible momentum that their decay length be as great as possible. If the incident beam be of protons, then the D-particles will be expected to be produced centrally and to have rather low momentum in the laboratory. However, if the incident particles are pions, then the D^o particles may be produced as "fragments" of the pion so that their laboraotry momentum will be high and their decay path long. A recent example of this argument was demonstrated at FNAL by Blaner et.al. [1] who observed that $\psi(3.1)$ particles produced forwards ($x > 0.5$) had a 7 times greater cross section in $\pi^- p$ reactions as in pp reactions. Hence we propose an experiment using a negative pion beam of the highest possible energy ($\gtrsim$ 390 GeV)in the 15-foot hydrogen bubble chamber. We would measure all V^o particles observed and try to identify any anomalous decays that could indicate D^o production.

A second aim of the experiment is a longer-range one - to study the energy dependence of various reaction processes. We have already begun to study 100 GeV/c $\pi^- p$ reactions in the 30-inch chamber and are requesting photographs of 100 GeV/c $\pi^- p$ in the 15-foot chamber. It has been shown that considerable information may be obtained from the energy variation of exclusive reaction channels. At 400 GeV/c it should still be possible to identify 4-constraint channels and with 50,000 photographs one may expect $\gtrsim$ 2000 events of the $p\pi^+\pi^-\pi^-$ channel. It will not be possible in general to separate one-constraint channels. However, it is hoped

that in some cases the interaction of an emitted neutron will allow a 3C or 4C fit to be obtained. The question is discussed in more detail in Proposal 267.

2. BEAM

It is requested that the beam be of the highest possible momentum to give the highest probability of detecting new particles. Thus if the accelerator is operated at 400 GeV, the π^- beam would be $\approx$ 390 GeV. No additional equipment (e.g. Cerenkov counter or hodoscopes) is needed as the beam will be almost purely π^-.

3. SCANNING AND MEASURING

The Collaboration has a considerable scanning and measuring capacity. In particular CERN has the ERASME scanning and measuring system which is designed for large bubble chambers with fish-eye optics. In addition CERN is constructing a series of Bessiematic tables with computer on-line which are intended for scanning film from large bubble chambers. It is proposed that on receiving the 390 GeV film a rapid scan and measurement be performed for decays of neutral particles to obtain a result for the search for new particles as soon as possible. Then the other event types would be measured.

REFERENCE

[1] G.J. Blanar et.al., Phys. Rev. Lett. 35 (1975) 346.