SEARCH FOR "NEW" PARTICLES FROM 400 GeV PROTON COLLISIONS IN EMULSIONS

Experiment No.

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REASEARCH PROPOSAL TO FERMI NATIONAL ACCELERATOR LABORATORY

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ABSTRACT

It is proposed to expose stacks of nuclear track emulsions to protons of 400 GeV. The emulsions will be examined by the method of area scanning for nuclear interactions. Each interaction will be examined for evidence of unstable particles having lifetimes between 10^{-17} and 10^{-12} second. Direct evidence for particles of these lifetimes is not possible in bubble chambers but the high resolution of the nuclear emulsion makes the proposed experiment feasible.

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INTRODUCTION

A number of experiments during the last few years have given evidence for new types of particles having lifetimes of the order of 10^{-16} to 10^{-12} second. The experiments of Niu et al[1] point to a particle or particles having mass between 1.5 to 3.0 GeV and lifetime of the order of 10^{-14} second.

Jain and Girard[2] have found evidence for an unstable neutral particle of lifetime $\sim 10^{-13}$ second. A "V" type decay was found in emulsion about 194 μm from the point of interaction of a 300 GeV proton. One of the two decay particles was an electron and the other probably a hadron. Multiple scattering estimates and other considerations yield a mass of $\sim$ 1.25 GeV and a lifetime of $\sim 10^{-13}$ second. While the observations are compatible with the kinematics of the decay of an ordinary $\Lambda(1115)$, the authors say this only has a probability of 10^{-6}.

The India-Japan cosmic ray experiment deep in the Kolar gold mine[3] has also given evidence for unstable

particles of lifetime $\sim 10^{-9}$ second and mass ~ 2 GeV. Six examples were found with a magnetic spectrometer apparatus having flash tubes as particle trajectory detectors.

Komar et al[4] have found possible information on the associated production of charmed particles. They found two events in emulsions exposed to a proton beam of 200 GeV in which a single electron of 1.0 GeV/c was emitted from one star and one of 0.45 GeV/c from another. In each event there were two tracks of high transverse momentum. These tracks were assumed to be due to the decay of a charmed meson and yielded masses of 1.8 GeV and 2.1 GeV respectively. The electron in each case was assumed to arise from the decay of an associated charmed baryon decaying as

$$B_c \longrightarrow \Sigma(\Lambda) + e^+ + \nu_e + n\pi$$

PROPOSED EXPERIMENT

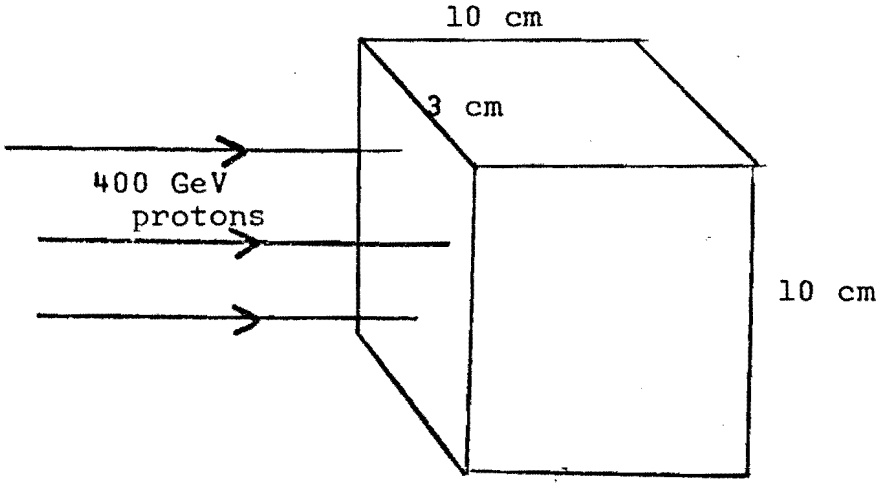
At the present time there are a rather large number of events interpreted as "new" particles of the long-lived type[1,2,3,4]. However, since these data do not seem to point to a unique particle or set of particles, the scientific community is not too convinced of their existence. It is clear that more research is required in this field in order to obtain greater statistics or to find events having more definitive decay modes.

Investigations have been carried out with emulsions exposed to protons of 200 and 300 GeV as well as pions of 200 GeV and muons of 150 GeV. The availability of protons of 400 GeV provide the opportunity to look once more for the production of the "new" particles. Should there be any threshhold for their production near 400 GeV, an experiment at this higher energy could be invaluable.

In some of the previous experiments[1,3], the vertices of the decay were outside of the track sensitive portion of the detector. In the experiment herein proposed, the detector is a stack of pellicles which will allow a close examination of the actual vertex of each event.

EXPERIMENTAL APPARATUS

It is proposed to expose 6 stacks of Ilford pellicles, 600 microns in thickness. Each stack will contain 24 sheets of emulsion and will have dimensions shown in the sketch below:



Each stack should be exposed to a maximum of 250,000 protons per cm^2

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