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PROPOSAL TO STUDY THE INTERACTIONS OF 100 GeV π^+ MESONS WITH DEUTERONS IN THE 30-INCH DEUTERIUM FILLED BUBBLE CHAMBER

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We propose to study the interactions of 100 GeV/c π^+ mesons in the 30-inch deuterium filled bubble chamber. The beam would ideally be a highly purified tagged beam created via production on a secondary target by an intermediate negative beam. If this turns out to be impractical, the present beam would be used. 50,000 pictures are requested for a pure π^+ beam or 100,000 pictures in the present beam (50% π^+). Use of a downstream detector is envisioned.

The Purdue High Energy Bubble Chamber Group (Task A)

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I. Proposal

We propose to take and analyze 50,000 pictures of π^+ interactions in the 30-inch deuterium filled bubble chamber. The beam would ideally be a highly purified tagged beam created via production on a secondary target by an intermediate negative beam. Alternately, one would enrich the pions by using a primary beam of energy greater than the normal 300 GeV. If these schemes turn out to be impractical, the present beam would be used. In the latter case (of 50% π^+ beam composition) we would require 100,000 pictures. In any case K^+ particles in the beam would be tagged and analyzed. They occur at the few percent level.

We would anticipate using a downstream detector facility to improve our measurements of the high momentum tracks.

II. Physics Interest

The 30-inch bubble chamber program has produced a mass of interesting data[1] on multiplicities, single particle production, particle correlations, diffraction production, elastic and total cross sections and more. The experiment proposed here would allow us to study for the first time such properties of the interactions of π^+ mesons with neutrons. In particular:

A. Interactions with neutrons.

1. Multiplicities: The interactions with neutrons would give a multiplicity distribution over the odd numbers of charged tracks and allow a more complete comparison with models.

2. Single particle production: One can make the usual studies of differential inclusive cross sections in π^+ and π^- production as well as search for scaling. In addition, it will be interesting to look at protons produced non diffractively in the neutron target core to get new insight

into multiperipheral chains. Further it will be interesting to look for a possible enhancement of Λ^o production from a neutron target by non charge exchange processes.

3. Particle Correlations: Multiparticle production data show that charge exchange between the beam and target hemispheres is suppressed. We will be able to extend these studies to the case where the beam is charged and the target neutral.

4. Diffraction: We will be able to study the diffraction of the neutron into an even number of charged particles. In particular $n \rightarrow p\pi^-$ is likely to be highly favored. Hopefully it will be possible to isolate the double diffraction process in five particle final states.

5. Total Cross Section: We will be able to obtain total cross sections for π^+ collisions with neutrons.

B. Interactions with Deuterons

1. If our experience at intermediate energies is relevant,[2] we can assume that an unbroken deuteron in an interaction is a clear indication of diffraction dissociation of the meson system. It at least implies isoscalar coupling to the deuteron. It will be particularly interesting to look for such events with 3 and 5 pions produced and compare the cross sections and two-body correlations to our data at 13 GeV/c[3].

2. We will obtain a point at A=2 for particle production on nuclei.

C. Comparisons of Similar Reactions: In addition to comparing 100 GeV/c $\pi^+ d$ data to 13 GeV/c $\pi^+ d$ data, we will be in the unique position of comparing 100 GeV/c $\pi^+ d$ data to 100 GeV/c $\pi^+ p$ and pp data which we are currently analyzing. This will allow us to make detailed comparisons of these data

and avoid the problems of comparing data analyzed under different sets of rules and selection criteria.

III. Exposure and Analysis

An exposure of 50,000 π^+ pictures will give approximately 10,000 analyzable interactions on neutrons. This assumes the usual seven tracks per picture. With the Purdue High Energy Group measuring bubble chamber pictures at approximately 200,000 events per year we should be able to do a rather complete analysis in less than six months. We are completely familiar with the N3 beam and tagging system. We are currently making use of the Expt. 2B hybrid system for measuring forward tracks.

References:

1. "Experimental Results on Strong Interactions in the NAL Hydrogen Bubble Chamber," J. Whitmore (NAL), Physics Reports to be published.
2. "Coherent Production of High-Mass Meson States in π^+d Collisions at 13 GeV/c," K. Paler et al. (Purdue), Phys. Rev. Letters 26, 1675(1971).