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η^0 NEUTRAL DECAY MODES

A proposal for a parasite experiment to be done during the Neutrino Experiment Preparation Runs with the CERN Heavy Liquid Bubble Chamber in the m2 beam, October to December 1962.

To be presented by the Ecole Polytechnique to the T.C. Committee 26 September 1962

$$\pi^+ + n \longrightarrow p + \eta^0 \qquad \pi^+ \text{ of } 1.2 \text{ GeV/c}$$

INTEREST

1. To Gain Experience which will be useful for the neutrino experiment, both in optimizing the performance of the bubble chamber, and in measuring and analysing electrons and π^0's (as well as charged π's) which are expected to be decay products of neutrino produced intermediate bosons.

For these purposes it is preferable to run the bubble chamber with the same liquid (CF_3 Br freon) and same magnetic field (27 KG, 3 generators) as will be used in the neutrino experiment.

2. η^0 Branching Ratios

The short radiation length of freon CF_3 Br (11 cm) and the large size (1.15 m diameter) of the bubble chamber give a γ ray detection efficiency $\geqslant$ 95 o/o for γ rays originating in a central fiducial volume $\sim$20 cm in diameter. Thus the modes $\eta^0 \rightarrow 2\gamma$, $\eta^0 \rightarrow 3\pi^0$ etc, could be separated with high efficiency; due to this high detection efficiency, the absence of modes $\pi^0+\gamma$, $\pi^+ \pi^- \gamma$, $\pi^0 + \pi^0 + \gamma$, etc. could be verified directly at the scanning stage. Use of $\pi^+ + n$ (instead of $\pi^- + p$) facilitates scanning and identification, since the struck neutron becomes a visible proton.

3. Correlations and Spectra in 3 body η^0 decay

Experience with the Ecole Polytechnique heavy liquid chamber indicates that π^0 momenta could be measured to about $\pm$ 12 o/o - 15 o/o in freon in the CERN HLBC, using only the curvature + directions of the primary electron pairs, without including information from the rest of the shower. Thus, even if no new techniques are developed for measuring π^0 energies this accuracy should permit detection for example of a possible ABC anomaly in the 3π correlations.

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4. Possible other Boson Resonances Decaying into γ's, π^o's, $e^{\pm}$

In the process of searching for η^o neutral decay modes, neutral decay modes of any other possible bosons of mass less than about 840 MeV would of course also be detected if produced copiously enough by 1.2 GeV/c π^+.

CONDITIONS OF RUN-YIELD

50 to 100.000 photos (8-15 shifts) at $\sim$4 π^+ / photo gives $\sim$1 interaction per photo in a central interaction volume or $\sim$1500 events of 1 mb cross-section, thus $\sim$1000 useful events of $\pi^+ + n \rightarrow p + \eta^o$ in 50,000 photos assuming cross-section 0,8 mb for the neutral mode (Pevsner - CERN Conf 1962) for π^+ of 1.2 GeV/c; Liquid CF_3Br (ρ = 1.5, Xo = 11 cm); Magnetic field 27 KG (7,500 a, 3 generators).

M2 beam tuned to π^+ 1.2 GeV/c should give $4\pi^+$/10" circulating protons on fast burst using less than 1 o/o of the PS beam (CERN/TC/HBC 81, 62/15, 12. 3.1962). Thus the possibility of parasiting during the set-up of the m2 beam is being examined. If this turns out to be possible, a more extensive "catalogue" of tracks relevant to the neutrino experiment could be taken while parasiting on beam set-up and perhaps counter experiments, ($\mu^{\pm}$, $\pi^{\pm}$, p of various momenta) and thus avoiding competition with other track chambers for magnet power.

CONCLUSION

The relevance to neutrino experiment preparation, the importance of η^o neutral decay modes and the possibility of doing the experiment parasitically during the m2 beam set-up without necessity of scheduling additional machine time, would seem to justify serious consideration of this proposal.

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