MUON PHYSICS IN THE 25-FOOT BUBBLE CHAMBER

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ABSTRACT

We propose to study the inelastic interaction of high energy polarized μ^+ mesons in the 25-foot hydrogen bubble chamber located in the "neutrino area." Using about 100 muons per pulse in the 100-200-BeV energy region, for a 10^6 photo experiment, the 25-foot chamber allows one to obtain about 6,000 events for a 2 μb cross section. Thus rare processes at the level of 10^{-2} μb become accessible.

I. PHYSICS DISCUSSION

A. N^* Production

A recent experiment[1] using 3 BeV/c muons in the CERN heavy liquid chamber yielded a cross section for N^* production of 1.4 μb. Assuming the high-energy cross section to be the same, we estimate (see Table I) that our run would yield 4,200 events. Because of the large number of N^* events, we would be able to analyze the angular decay correlation effectively. We would take advantage of the muon polarization in analyzing the decay angular distribution of the N^*, in order to unfold the various N^* form factors.

Table I. Estimated Inelastic Rates

Reaction	σ(μb)	No. Events Expected
N^*	1.4	4,200
Multiple Pion	0.6	1,800
Total Inelastic	2.0	6,000

B. Current Algebra Tests Using Soft Pions

1. Adler and Weisberger[2] have suggested that the process $\mu^+ + p \rightarrow \mu^+ N^* + \pi$ (soft) might be used to measure, albeit via PCAC, the axial nucleon form factor.

2. Bjorken[3] suggests a similar study using the reaction $\mu^+ + p \rightarrow \mu^+ + N + \pi$ (soft), where the effective mass of the $N\pi$ system is below the 3, 3 resonance. About 25% of single pion production is expected to be due to s-wave pions.

In both (1) and (2), a detailed study of the final state, using the bubble chamber, allows one to unfold the soft pion s-wave contribution from the "background" of resonance phenomena.

C. Coherent Vector Meson Production

We will be able to study the reaction

$$\mu^+ + p \rightarrow \mu^+ + p + \rho^o$$

$$\rightarrow \mu^+ + p + \omega^o ,$$

in order to test vector dominance models. Polarized μ^+ will be useful in the angular correlation studies.

D. Search for μ^*

If the excited muon exists and has a μ-γ decay mode, our experimental sensitivity corresponds to a cross-section limit of $\sigma \leq 4 \times 10^{-34}$ cm^2. This corresponds to an improvement of sensitivity of two orders of magnitude over existing experiments.[1]

II. EXPERIMENTAL REQUIREMENTS

A muon beam facility should be incorporated into the neutrino area. For preliminary experiments, a beam quality of $\pm 3\%$ in $\Delta p/p$, for p in the neighborhood of 150 BeV/c, is required. In addition, a tuning capability of the beam from about 50 GeV/c to 150 BeV/c (in perhaps 3 steps) is highly desirable. The 25-foot bubble chamber filled with H_2 is satisfactory. However, a long and thin hydrogen target surrounded by neon is most advantageous. This geometry would cause no loss in event rate but would permit γ ray and neutron detection and measurements.

REFERENCES

[1] H. Wachsmuth, private communication.

[2] S. L. Adler and W. I. Weisberger, Preprint (CERN library Pre-8106).

[3] National Accelerator Laboratory Study Group, 1969, private communication.