

SOME SPECULATIVE μ EXPERIMENTS

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A Test of Lepton Quantum Numbers: Additive or Multiplicative?

In a weak or a electromagnetic process, μ^- - lepton (1_μ) and e^- - lepton (1_e) numbers should separately be conserved. A process such as:

$$\begin{array}{ccccccc} \mu^- & \mu^- & \rightarrow & e^- & e^-, & & \\ 0 & 0 & & -1 & -1 & & 1_e, \\ +1 & +1 & & 0 & 0 & & 1_\mu, \end{array} \quad (1)$$

will be forbidden if the lepton quantum numbers are additive. However, this would be an allowed reaction if the lepton quantum numbers are multiplicative. A proposed test for this conservation law will be:

$$\mu^+ A \rightarrow \mu^- e^+ e^+ A, \quad (2)$$

and can be represented in a schematic diagram as follows:

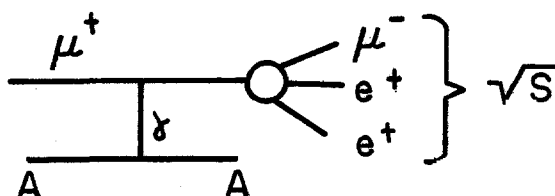


Fig. 1

also

$$\sqrt{S} = 2 P_{\mu} (E_{\gamma} - P_{\gamma}) + q_{\gamma}^2, \quad (3)$$

where

S is the total energy squared of the $(\mu^{-} e^{+} e^{+})$ system,

P_{μ} is the momentum of μ^{-} ,

E_{γ} , P_{γ} , and q_{γ}^2 are energy, 3-momentum, and 4-momentum

of the virtual γ .

$A(Z)$ is a heavy nucleus.

If this process has a cross section of the order of 10^{-38} cm^2 (competing with usual electromagnetic process of 10^{-30} to 10^{-33} cm^2), detections of μ^{-} , e^{+} , e^{+} in the final state would be difficult. However, if this process were manifest by a new interaction, then the cross section of this reaction could be as large as the usual electromagnetic process. One can also enhance the rate by an order of magnitude by means of the coherent process in a high- Z target, the experimental setup can be roughly shown below:

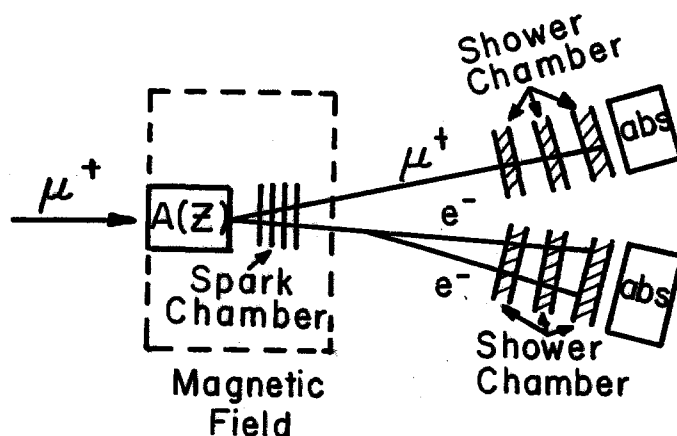


Fig. 2.

Using shower chambers in both arms, one can also obtain events of the reaction

$$\mu^{\pm} A \rightarrow \mu^{\pm} e^{+} e^{-} A. \quad (4)$$

This process should also provide a test for Q. E. D.

Search for Heavy Leptons of μ -Type

One can use the missing-mass type of experiment with μ 's as the incident particles in the reaction (for example):

$$\begin{aligned} \mu^{\pm} P &\rightarrow P X^{\pm} \\ &\quad \searrow \mu^{\pm} \gamma, \end{aligned} \quad (5)$$

in a setup such as

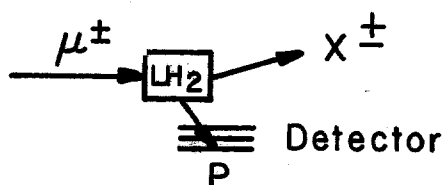


Fig. 3.

If the X^{\pm} has a life time of 10^{-21} sec as suggested by F. Low for electron type of heavy leptons, then one can observe this object of a few MeV in width (comparable with the experimental resolution by selecting an appropriate Jacobian angle of the recoil protons). Figures 4 and 5 show kinematic plots of $\cos \theta_p$ vs P_p in the lab system at incident μ^{\pm} momenta of 6 and 50 GeV/c, with the X^{\pm} mass as parameter.

Form Factor Study of Nucleon Isobars

Examine the form-factor behaviors of various known nucleon isobars and compare them with that of nucleons (double-pole fit to the form factor). In particular, the behavior of P_{11} nucleon isobar $[N^{*} 1/2 (1400)]$ is of great interest in inelastic reactions, such as

$$\begin{array}{c} \mu P \rightarrow \mu N^{*} \\ \quad \downarrow \\ \quad \left\{ \begin{array}{l} \pi P \\ \Lambda K, \end{array} \right. \end{array} \quad (6)$$

at high energy as a function of 4-momentum transfer.

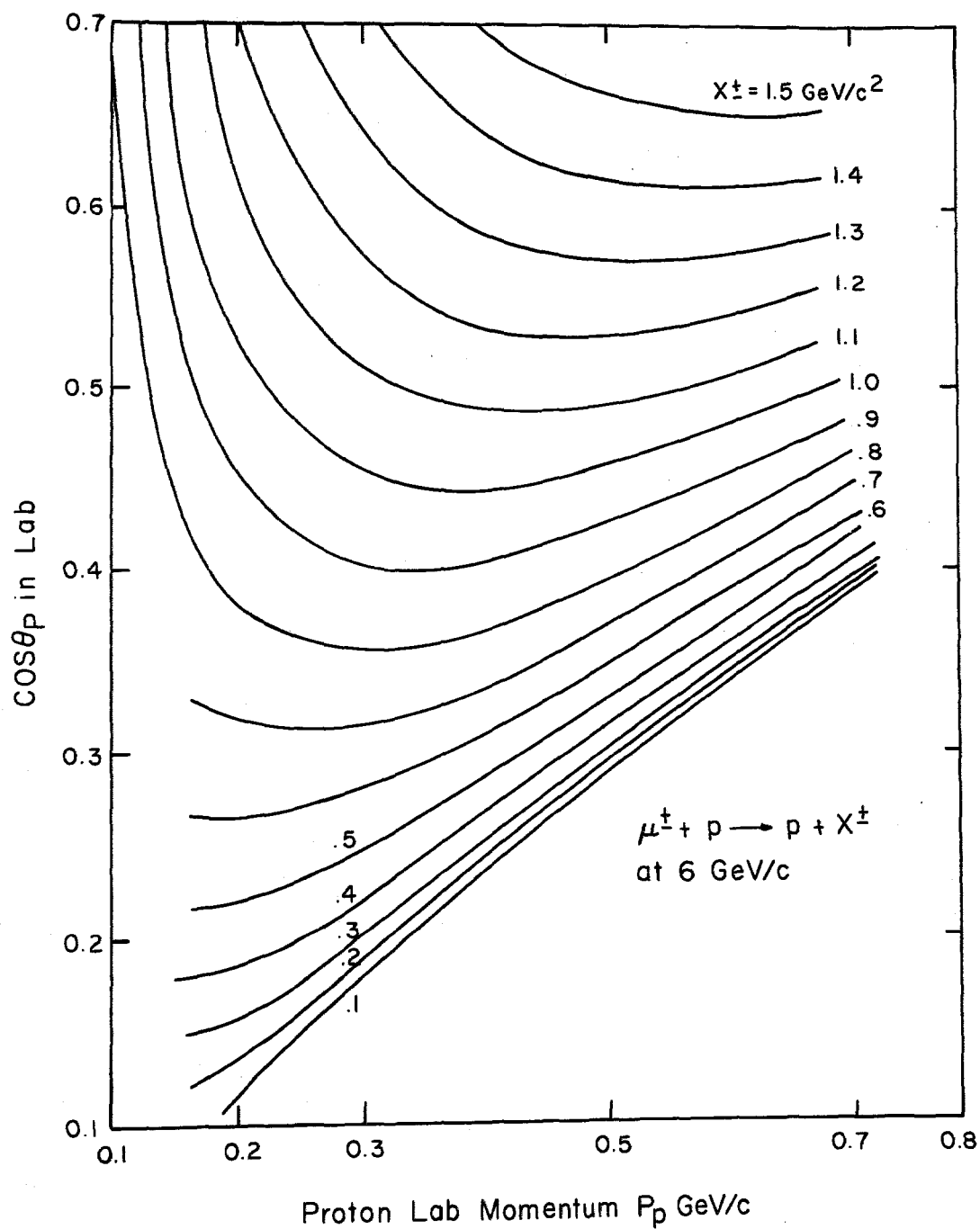


Fig. 4. Distribution in angle and momentum of secondaries from μ - p interaction, as a function of the mass of the particle produced; primary momentum $6 \text{ GeV}/c$.

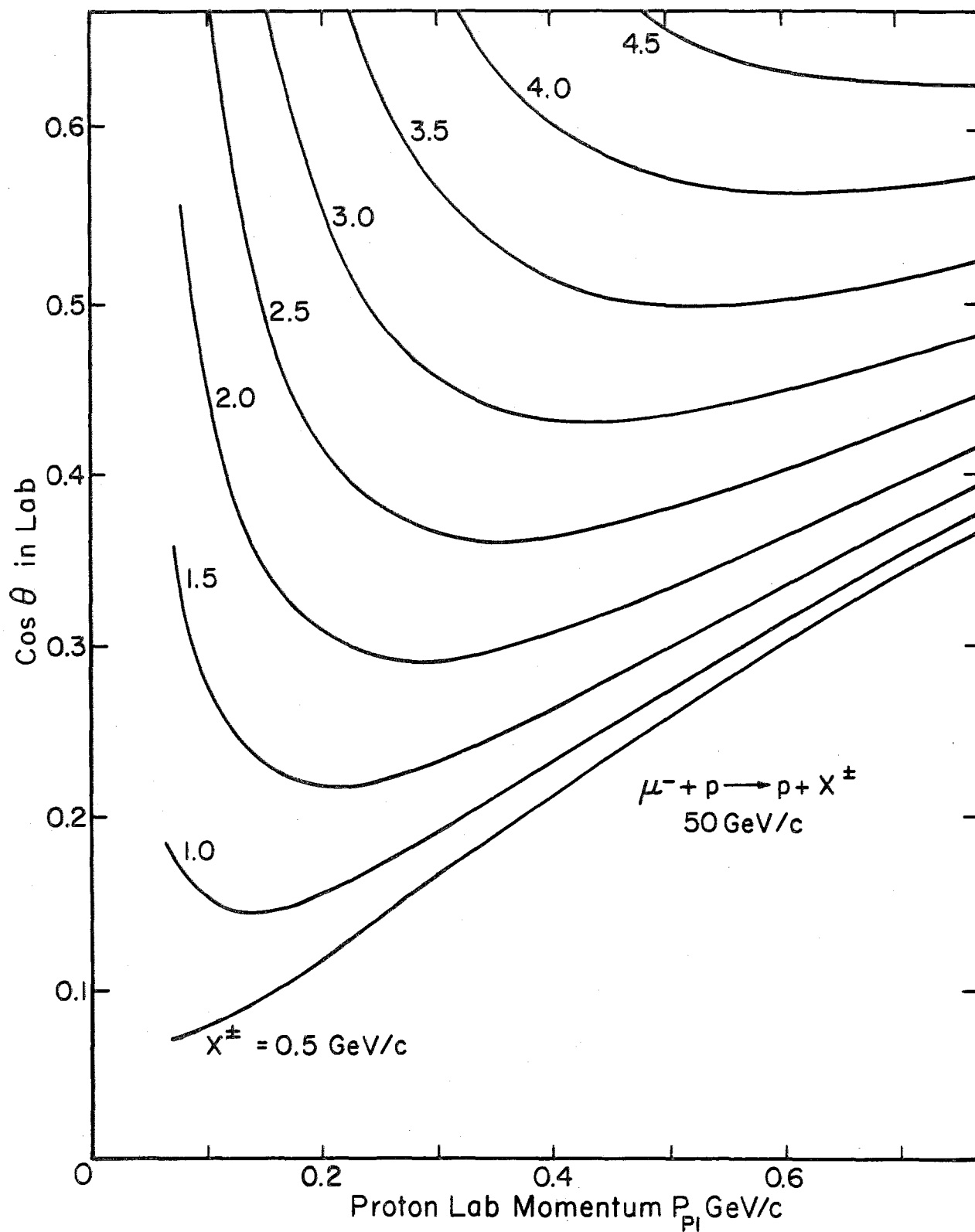


Fig. 5. Same as Fig. 4, for primary momentum 50 GeV/c.