

RESEARCH PROPOSAL TO CEBAF

**Search for Direct Conversion of Electrons  
into Muons**

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Abstract

We propose to search for the lepton number violating reaction:  
 $e^- + p \rightarrow \mu^- + X$  where  $M_X$  is in the range:  $M_p < M_X < M_p + 1250 \text{ MeV}$ .  
The highest sensitivity will occur when  $X$  is a narrow state, lepto-proton,  
produced in association with a  $\mu^-$ . The proposed experiment will extend  
the search for lepton number violation well beyond the limits of previous  
experiments by probing for new mechanisms. Longitudinally polarized  
electron beams, if available, at .3 GeV and 4. GeV will be used. To search  
for  $e^- + p \rightarrow \mu^- + X$  the Hall C HMS spectrometer, at an angle of  $12.5^\circ$ ,  
will scan  $\mu^-$  momenta corresponding to  $M_p < M_X < M_p + 1250 \text{ MeV}$  for  
the 4. GeV beam and  $M_p < M_X < M_p + M_\pi$  for the .3 GeV beam. (The  
spectrum of  $M_X$  could be a continuum and/or have well defined peaks.)  
Along with the measurements of the mass spectra, the beam polarization  
will be used to search for evidence of parity violation in the  $\mu^-$   
production. The detection of parity violation, even without a detailed  
understanding of the level of the backgrounds, would (by itself) be

evidence for a new type of interaction beyond the "Standard Model,"<sup>1)</sup> since all expected backgrounds do not violate parity.

For the .3 GeV beam, an indicator of the sensitivity of the experiment (for detecting a narrow lepto-proton) is the ratio,  $R_B$ , of background  $\mu^-$ s, upper limit, to detected elastic ep scattering. At  $54^\circ$ , an upper limit for  $R_B$  of  $R_B \approx 1 \times 10^{-6}$  has been shown to be achievable at Bates. Thus, in the proposed experiment direct conversion cross sections should be observable with a sensitivity much greater than  $\sigma(ep \rightarrow \mu x) \geq 1 \times 10^{-6} \sigma(ep \rightarrow ep)$  for  $M_p < M_x < M_p + M_\pi$ . For  $M_p < M_x < M_p + 1250$  MeV, at 4. GeV, the calculations are still being refined, but indicate a sensitivity of better than:  $\sigma(ep \rightarrow \mu x) \geq 1 \times 10^{-5} \sigma(ep \rightarrow ep)$ .

Requests: The Hall C HMS spectrometer operated for high resolution with muon detection. Longitudinally polarized beams, if available, of 60  $\mu$ A at .3 and 4. GeV, each for 24 hours. 10 cm liquid hydrogen target. (This experiment might be run simultaneously with the proposed experiment: "Search for Narrow Excited States of the Proton.")

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### Motivation

The most sensitive searches for  $\mu^- \rightarrow e$  conversion are:<sup>2)</sup>  $\mu^- \text{Ti} \rightarrow e^- \text{Ti}$  ( $\mu^-$  conversion in the field of a Titanium nucleus) and the search for the decay  $\mu^+ \rightarrow e^+ \gamma$ . However, these decays could be forbidden if  $\mu^- \rightarrow e$  conversion is mediated by a lepto-boson carrying both e and  $\mu$  quantum numbers which converts one of the nucleons to a lepto-nucleon. (The term lepto is used to indicate an object with non zero lepton number.) This possibility provides a strong motivation for the proposed experiment. For example, in this view, the reaction  $\mu^- \text{Ti} \rightarrow e^- \text{Ti}$  would be forbidden but