SLAC Proposal No. 16

PROPOSAL TO MEASURE THE INELASTIC SPECTRUM OF ELECTRONS SCATTERED FROM C^{12}.

Submitted

by

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July 1966

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1. Objective of the Experiment:

Christ and Lee[1] have suggested an experiment to test the charge conjugation invariance of strongly interacting particles in electromagnetic interactions. The reaction is $e + p \rightarrow e' + \Gamma$, where Γ is a nucleon resonant state, the target proton is polarized, and only the scattered electron is being detected. The C-violation will be revealed by the asymmetry in cross section for target protons polarized parallel and antiparallel to the normal of the scattering plane, which is of the following form:

$$a = \frac{[E_o^2 - E^2] < \sigma_p >}{M_p^2 \left[2W_1 + W_2 \cot^2 \frac{\theta}{2}\right]} W_3 \cot \frac{\theta}{2}$$

where $< \sigma_p >$ is the initial proton polarization; E_o and E, energies of the incident and scattered electrons; θ, the scattering angle; M_p, the rest mass of proton; and W_1, W_2 and W_3, the form factors at the γ-p-Γ vertex.

Several people in our group have been investigating this experiment for some time. In light of the recent observation[2] of an asymmetry in the 3π decay mode of η_o, the experiment suggested by Christ and Lee becomes more important because it can determine whether the observed C nonconservation is of electromagnetic origin or not. For the time being, the most promising target[3] appears to be polystyrene, $(CH)_n$,

doped with DPPH, $(NO_2)_3 C_6H_2NN(C_6H_5)_2$, or galvinoxyl, $O(C_4H_9)_2(C_6H_2)CH(C_4H_9)_2(C_6H_2)O$. Even with maximum C-violation, the final asymmetry in counting rate for "spin-up" and "spin-down" will be only (a maximum of) a few per cent because (1) the free protons in the target can not be completely polarized, and (2) there exists background from processes which exhibit no asymmetry. An important source of such background arises from inelastic processes on carbon nuclei in the target. At the momentum transfers involved in the region of interest, the carbon nucleus will break up and the scattering can be approximated by considering that each nucleon acts individually. Assuming a Fermi gas model to take care of the smearing effect due to the nucleon motion, we have made a calculation to predict the spectrum shape of electrons scattered from $(CH)_n$. One of the results is shown in Figure 1. The proposed Christ-Lee experiment depends critically ~~entirely~~ on the ratio of backgrounds (including radiative tails) so that an experimental check of this predicted curve is crucial.

Since our present rough look at the Christ-Lee experiment leads to small but possibly measurable effects, we would like to propose a measurement of the inelastic energy spectrum of electrons scattered from C^{12} at high energy and small angles. This, plus the information which we hope to obtain from the inelastic scattering on the proton will explore the experimental feasibility of the C-violation experiment.

2. Request for Running Time

The measurement can be performed in parallel with the Group A experiment[4] of inelastic electron scattering from the proton which

already has been approved, with a suitable change in target. Since the measurement is going to be done in regions where the electron counting rate is high enough so that accurate statistics could be accumulated in the Christ-Lee experiment, the actual counting time would be quite short. We would like to request 20 hours of beam time to run the experiment, and approximately half of that time would be at a repitition rate of 60 cps.

REFERENCES

1. N. Christ and T. D. Lee, Phys. Rev. 143, 1310 (1966)
2. C. Baltay et al., Phys. Rev. Letters 16, 1224 (1966)
3. Chester Hwang, private communication.
4. W. K. H. Panofsky et al., SLAC Experimental Proposal No. 4, unpublished, 1966.

Figure1: Spectra of electrons expected at 5° with 20 BeV incident beam: (1) roughly calculated spectrum from C^{12}, (2) inelastic spectrum from free proton, and (3) radiative tail from the elastic peak of free proton.