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ADDENDUM TO THE PROPOSAL FOR $\Delta S/\Delta Q$ EXPERIMENT

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In this note we wish to give more information about the expected K^0 flux, the determination of the K^0 momentum, the detector for leptonic decays and the proposed time-table.

I. The K^0 Beam

K^+ charge exchange on neutrons bound in complex nuclei is not expected to be coherent. The effective number of neutrons contributing to quasi-elastic charge exchange in Cu can be estimated to 3 per nucleus. The expected charge exchange rate in 3 cm Cu is then about 10^{-3} per incident K^+. The momentum spectrum of K^0 produced is unknown and may be wide. However, a precise knowledge of the K^0 momentum is of great importance, since it is the aim of the proposed experiment to study the decay distribution as a function of proper time.

To overcome these difficulties we propose to make use of the reaction

$$K^+ \, p \rightarrow K^0 \, N^{*++}_{1236} \qquad (1)$$

which occurs with a cross section of about 1 mb in the momentum range 2.5 to 3.0 GeV/c. Decay products of N^{*++}_{1236} are detected in wire spark chambers around a hydrogen target of 50 cm effective length. A forward cone for secondaries from K^0 decay in the target is left free. The overall acceptance for detection of N^{*++} is then 0.6.

Detection of secondaries from N^* decay serves two purposes:

(1) the intersection of π^+, p and the incident K^+ trajectory yields the production point of K^0;

2) from the directions of π^+ and p and the information on the decaying K^0, a 2 constraint fit of the production reaction can be obtained.

The ultimate precision on the K^0 momentum which can be obtained in this way is still being calculated. However, even if the mass of individual N^* produced in reaction (1) cannot be determined to better than the natural width (Γ = 120 MeV), the resulting K^0 spectrum will have a width $\Delta p/p = \pm 0.033$.

The expected K^0 rate from reaction (1) is then

$$N(K^0) = 1.3 \cdot 10^{-3} \; N(K^+) \; .$$

The existing m_4 beam would yield, for $3 \cdot 10^{11}$ protons on target #1, $5 \cdot 10^4$ K^+ at 2.5 GeV/c in a momentum band of $\pm 2.5 \cdot 10^{-2}$, and thus 65 K^0 per burst. The momentum band can probably be subdivided by small counter hodoscopes.

II. Detection of K_{e3} Decays

The acceptance of the K_{e3} detector has been improved by requiring two particles separated in two vertical cells of the Čerenkov counter. The layout of wire spark chambers before and after the magnet has been compressed. The average decay path is 10 Λ_S. This detector has an acceptance of $6 \cdot 10^{-2}$ averaged over the angular distribution of K^0 produced in reaction (1).

The expected rate of K_{e3} decays is then 935 per CPS day of $3 \cdot 10^4$ bursts. We prefer to multiply this figure by a safety factor of 0.5, to allow for various possibilities of event loss. In 3 periods of 10 days of data taking one could obtain 15000 events.

We have considered two different ways of analysing the data. A study of the function $\frac{\ell^+ - \ell^-}{\ell^+ + \ell^-}$ as a function of proper time does not require any knowledge of the time dependent detection efficiencies. Since the angular distribution of reaction (1) enters into the detection efficiency, it may only be determined ultimately by studying decays in the more abundant ($\pi^+ \pi^-$) mode. For 15000 events we then expect a precision of ± 1.5 % on (Re x + Im x) and ± 5% on Re x and Im x .

Once the detection efficiencies are known, it is more appropriate to study the function $(\ell^+ + \ell^-)$. A check on possible systematic errors in the time-dependent detection efficiencies can be obtained by studying $\ell^+ - \ell^- = C(1 - |x|^2) \cdot \cos(\Delta m t) \; \exp(-1/2\,(\Gamma_S + \Gamma_L)t)$, which should fit the known value of Δm. The precision can then be improved to $\pm$ 1% on Re x and $\pm$ 2.5 % on Im x.

III. Time-table

A wire chamber system for this experiment is under design and can be tested during the summer. Modification of a 2 m standard bending magnet and construction of the big Čerenkov counter is estimated to take 5 - 6 months. The experiment could be tested on the floor starting at the end of the year.