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B 4 Direct Determination of the Kaon Form Factor

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Determination of the kaon form factor in a space-like region has until now eluded experimental measurement. In electron-positron annihilation experiments the two-kaon final state is not dominated by simple resonance production and the extraction of the kaon form factor is not a straightforward matter, in contrast to the pion with its rho resonance dominance. For similar reasons electroproduction experiments cannot be usefully interpreted to produce the kaon form factor. Direct determination of a kaon charge radius by kaon scattering from electrons that had not been possible before Fermilab energies became available because the unique kinematic characteristics of scattering with a relatively massive projectile require such energies to produce momentum transfers sensitive to the kaon form factor.

We have used a 250 GeV negative kaon beam at the Fermi National Accelerator Laboratory to measure the cross section for elastic scattering from atomic electrons of a 51 cm long liquid hydrogen target for momentum transfers from 0.036 to 0.116 $(\mathrm{GeV}/c)^2$. The electromagnetic form factor for these kaons is determined by

$$\mathrm{d}\sigma/\mathrm{d}q^2=(\mathrm{d}\sigma/\mathrm{d}q^2)_{pt}\cdot|F_K(q^2)|^2$$

where the point cross section is, apart from radiative corrections

$$(\mathrm{d}\sigma/\mathrm{d}q^2)_{pt}=\frac{4\alpha^2}{q^4}(1-q^2/q^2_{\mathrm{max}})$$

The mean squared radius is determined by

$$\langle r_K^2\rangle=-6|\mathrm{d}F_K(q^2)/\mathrm{d}q^2|_{q^2=0}$$

Elastic scatters were recorded by a high-resolution, single arm spectrometer which is illustrated in Fig. 1. The incident beam kaon and the scattered kaon and electron were tracked by both proportional wire chamber (PWC) stations and drift chamber (DC) stations.

Both chamber types were used in track finding and event recontruction to provide the high redundancy required for good efficiency. With PWC calibration an overall drift chamber resolution of approximately 100 μm was achieved and made possible good discrimination against the copious strong interaction background. The momentum of the scattered kaon and of the electron were determined by two magnets with a total field integral of 70.35 kg-m followed by three PWC stations. This was followed by a 21 radiation length lead-glass shower counter system which was used in the trigger and in the final background determination.

From the measured elastic scattering cross section and from the point cross section corrected to the measured electron energy, the form factor was determined as a function of the measured q^2. Our preliminary results are

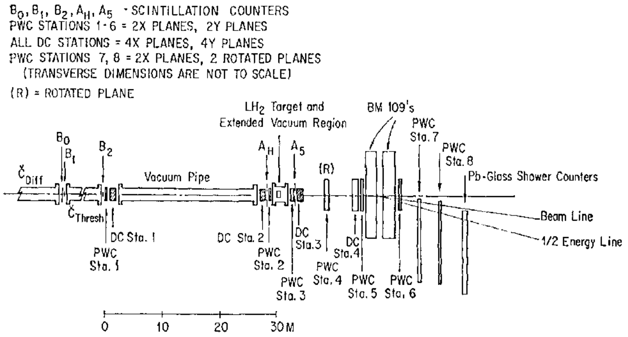

Fig. 1. High resolution single arm spectrometer.

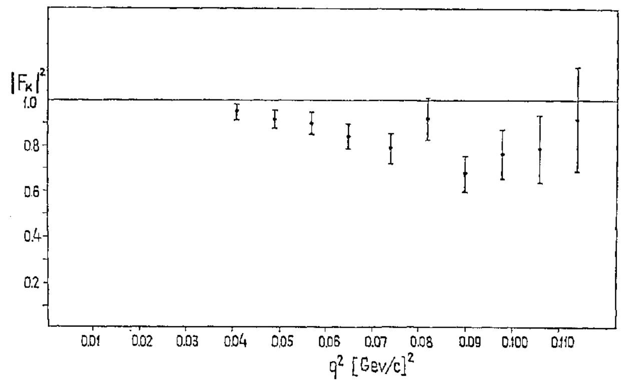

Fig. 2. Preliminary results on the kaon form factor as a function of q^2.

shown in Fig. 2. A fit to the dipole form gives $\langle r_K^2 \rangle = 0.26 \pm 0.07 F^2$ (or $\langle r_K^2 \rangle^{1/2} = 0.51 \pm 0.07 F$). This may be compared to $\langle r_\pi^2 \rangle = 0.31 \pm 0.04\ F^2$ (or $\langle r_\pi^2 \rangle^{1/2} = 0.56 \pm 0.04\ F$) for the pion.[1] An accurate theoretical prediction has not been produced, but it is of interest to compare our result with the Chou–Yang model in which the kaon structure function is identified with the electromagnetic form factor. The model gives $\langle r_K^2 \rangle^{1/2} = 0.62\ F^2$.

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References

1. E. Dally *et al.*: Phys. Rev. Letters **39** (1977) 1176.
2. T. T. Chou: Phys. Rev. **D11** (1975) 3145; A more recent analysis gives $\langle r_K{}^2 \rangle^{1/2} = 0.52 \pm 0.08$ F (T.T. Chou, private communication).