RARE DECAYS AND CP VIOLATION IN THE NEUTRAL KAON SYSTEM AT THE TEVATRON

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In Figure 1 we present the expected[1] K_L flux in a (large) neutral beam at the Tevatron. Also shown is the neutral spectrum. It is assumed that the gamma flux has been removed with a 3-in. lead converter.

Total kaon flux $\approx 5 \times 10^8$/pulse

Total neutron flux $\approx 4 \times 10^9$/pulse

Total K_L decays = $\approx 1.5 \times 10^7$/pulse in 150m decay region

For the study of the possible decays $K_L \to \mu e$ or $K_L \to \pi\mu e$, a Monte-Carlo calculation has shown that a modest detector can be built having an average detection efficiency over the momentum spectrum and decay region of better than 10%. This figure can be obtained with all elements active only outside the hot neutron beam. In addition, the neutron flux can be severely attenuated with a slight increase in production angle while the K_L flux is hardly affected. Thus one can effectively sample over 10^6 decays per pulse. This would permit an "ultimate limit" measurement at the 10^{-11} level. The backgrounds remain to be simulated at this level.

The higher energy K_L's produced at the Tevatron, while not an advantage in looking for decay processes, can be exploited in the Primakoff process. Here an incident K^0 is excited to a K^* (892) in the Coulomb field of a heavy nucleus, the K^* (892) then decaying copiously to $K^0\pi^0$. Several features of this process should be noted:[2]

(1) In an incident K_L beam, **only** $K_S{}^0$ will be observed (i.e., $K_L{}^0$ is forbidden by CPT).

(2) The process occurs at very large impact parameters and the resulting strong forward peaking is a particularly good handle for identification.

(3) The cross section itself is of interest, being directly proportional to the K^* (892) $\to$ $K^0\gamma$ radiative decay width. It is large ($\approx 10^{-3}$ of the total cross section with a Pb target), grows (logarithmically) with energy, and is particularly free of strong backgrounds which are dominated by ω-exchange and hence fall with a power of the incident energy.

It is estimated that the decays of several million "tagged" K_S's could thus be observed in a typical experiment. In particular, this would allow the detection of the as yet non-observed $K_S \to \gamma\gamma$ decay channel; however, the study of CP violating effects in this channel[3] would most likely still remain out of reach.

Finally, we note that the Tevatron appears to offer no particular advantage over the present accelerator for the study of the CP-nonconservative parameter ε'.

References

1. We have scaled the results of P. Skubic et al., Phys. Rev. **D18**, 3115 (1978), and R. T. Edwards et al., Phys. Rev. **D18**, 76 (1978) to 1000 GeV.

2. See, for example, W. Molzon, Ph.D. Thesis, University of Chicago Physics Department, 1979 (unpublished).

3. See J. Ellis, M. K. Gaillard, and D. V. Nanopoulos, Nucl. Phys. **B109**, 213 (1976).

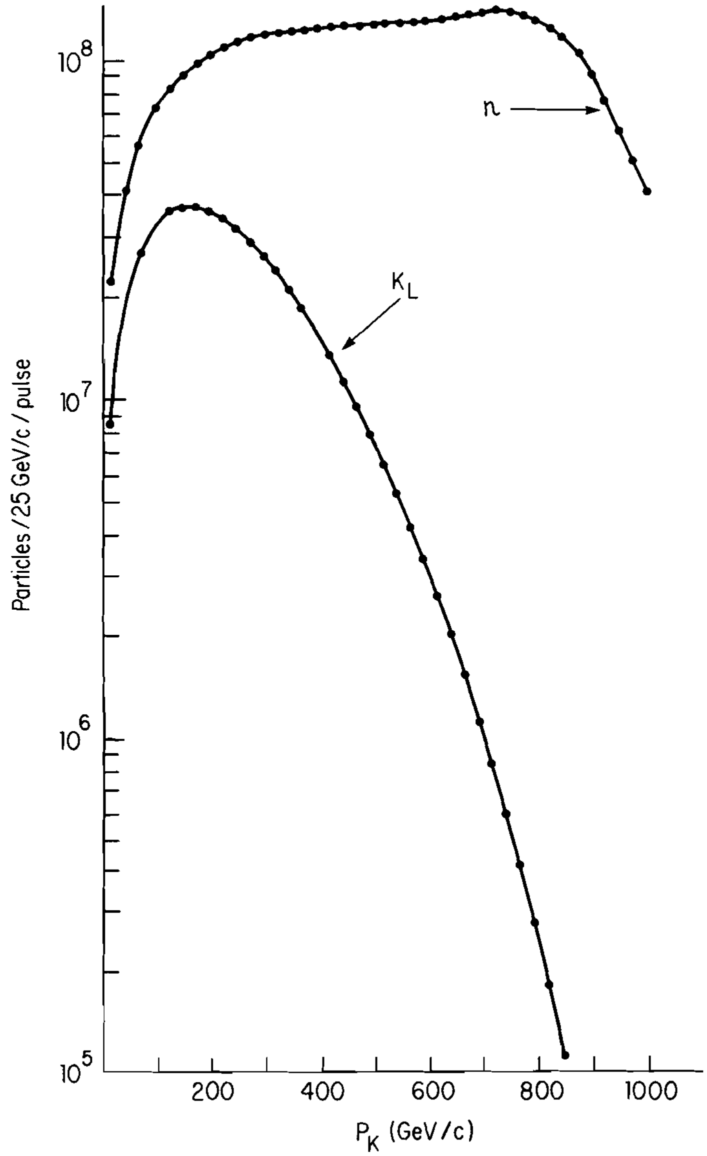

Fig. 1 K_L and neutron flux in meson detector building at the Tevatron