K⁰ - K̅⁰ oscillation

Pure K⁰ beam at t=0

Produce an initial K⁰: K⁺ + p \rightarrow K⁰ p \pi^+

K⁰(t=0) \rightarrow t: \ K⁰ \rightarrow \pi^- e^+ \nu

K⁰(t=0) \rightarrow t: \ K̅⁰ \rightarrow \pi^+ e^- \nu

Niebergall et al.,
FIG. 3. Angular distribution in three mass ranges for events with \( \cos \theta > 0.9995 \).
CP Violation

\[ \frac{N(K_L \rightarrow \pi \pi)}{N(K_L \rightarrow X)} = \frac{45 \pm 9}{22700} \approx 2 \times 10^{-3} \]
CP Violation: Interference-effect

**K_L → πππ and K_S → πππ** can interfere:

We see not only the effect of regenerated **K_S → πππ** but also effect of interference term which oscillates in time.

Figure 7.26  (a) Event rate for π^0 π^- decays from a neutral-kaon beam as a function of proper time, demonstrating the best fit needs the existence of interference between **K_τ^-** and **K_μ^-** amplitudes. (b) The interference term extracted from the results in (a). From the fit one can obtain the **K_L - K_S** mass difference Δm and the phase angle ϕ_+ - ϕ_- between the two amplitudes. (After Geweniger et al. 1974.)

Geweniger et al. (1974)
The CPLEAR experiment at CERN

$\bar{p}p$ (at rest) $\rightarrow K^-\pi^+K^0$
$K^+\pi^-\bar{K}^0$

Antiprotons $\bar{p}$ hit a hydrogen target

$\sigma(M_{K^0}) \approx 13$ MeV/$c^2$
$\sigma_{\tau} \approx (5 - 10)$ ps
Ultimate measurement

1999

Effekt $\sim 10^{-3}$