Rare kaon decays

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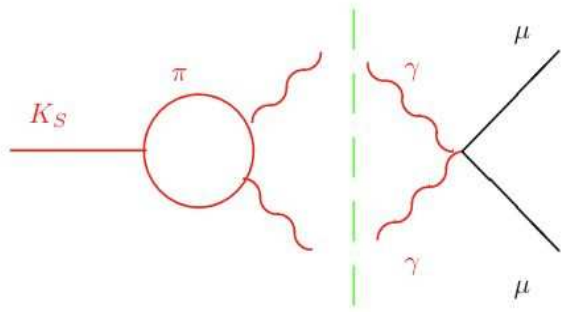
- Searching for silver bullet

$K_S \to \mu\overline{\mu}$

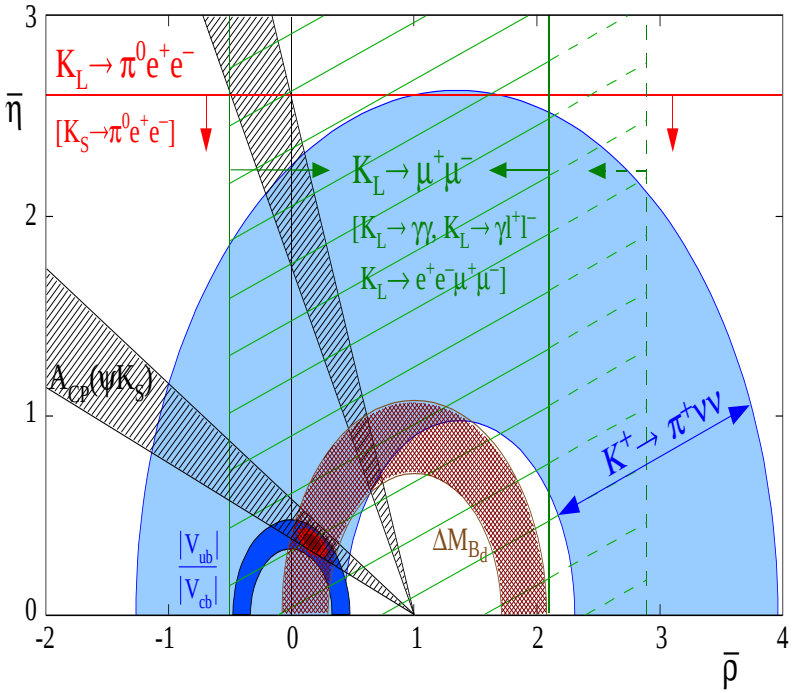
- LHCB $B(K_S \to \mu\overline{\mu}) < 11 \times 10^{-9}$ at 95% CL after 40 years
- Long Distance dominated ($\sim 5 \times 10^{-12}$) , Short distance ($\sim 1.4 \times 10^{-12}$): **ONLY CP Violating**
- SM $B(K_S \to \mu\overline{\mu})_{SD} = 1 \times 10^{-5} |\Im(V_{ts}^* V_{td})|^2 \sim 10^{-13}$; NP $\sim 10^{-11}$ allowed;



μ-Polarization in $K_L \to \mu\bar{\mu}$

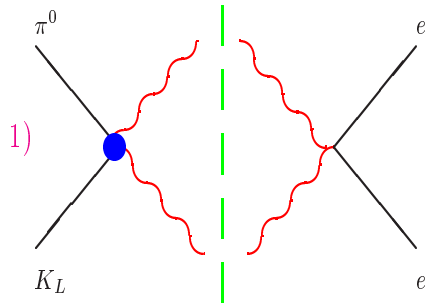
- $P_L = \dfrac{N_R - N_L}{N_R + N_L} \overset{\text{SM}}{<} 2 \cdot 10^{-3}$ Herczek,Ecker and Pich
- Left-Right Models and leptoquark exchange may generate $P_L \sim \mathcal{O}(10^{-2}, 10^{-1})$ Hewett,Rizzo,Thomas
- $B(K_L \to \mu\bar{\mu}) = (7.27 \pm 0.14) \cdot 10^{-9}$ PDG

Importance $B(K_L \to \mu\bar{\mu})$



$K_L \to \pi^0 e^+ e^-$: summary

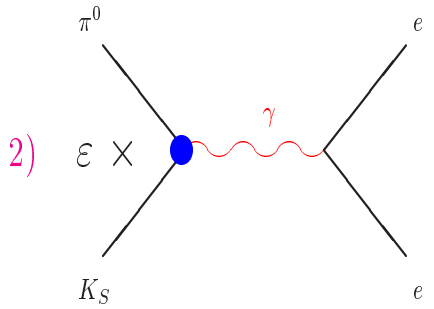
$\mathrm{Br}(K_L \to \pi^0 e^+ e^-) \leq 2.8 \cdot 10^{-10}$ at 90% CL KTeV

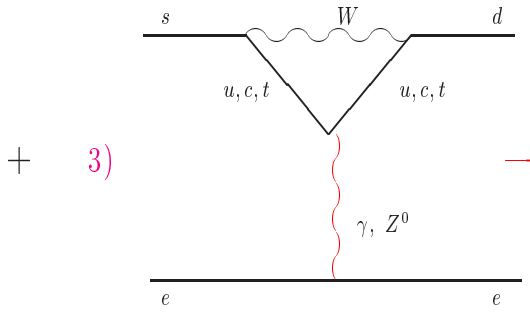


CP conserving NA48

$\mathrm{Br}(K_L \to \pi^0 e^+ e^-) < 3 \cdot 10^{-12}$

V-A$\otimes$ V-A $\Rightarrow \langle \pi^0 e^+ e^- | (\bar{s}d)_{V-A} (\bar{e}e)_{V-A} | K_L \rangle$ violates CP





$\longrightarrow$ Im λ_t

$\lambda_t = V_{td}V_{ts}^*$

$\uparrow \mathrm{B}(K_S \to \pi^0 e^+ e^-) = 4.6 a_S^2 \times 10^{-9}$

Possible large interference: $a_S < -0.5$ or $a_S > 1$; short distance probe even for a_S large

$$|2) + 3)|^2 = \left[15.3\ a_S^2 - 6.8 \frac{Im\lambda_t}{10^{-4}}\ a_S + 2.8 \left(\frac{Im\lambda_t}{10^{-4}}\right)^2\right] \cdot 10^{-12}$$

$$[17.7 \pm \qquad 9.5 + \qquad 4.7] \qquad \cdot 10^{-12}$$

Rare Kaon decays at LHCB

- $K_S \to \mu^+\mu^-$
- $K_S \to \mu^+\mu^-\mu^+\mu^-$, search for instance Dark photons and Standard Model
- Charge asymmetry $K^\pm \to \pi^\pm\mu^+\mu^-$ (SM $\sim 10^{-4} \Longrightarrow$ NP)
- Forward backward asymmetry