

Rare Kaon decays at LHCb

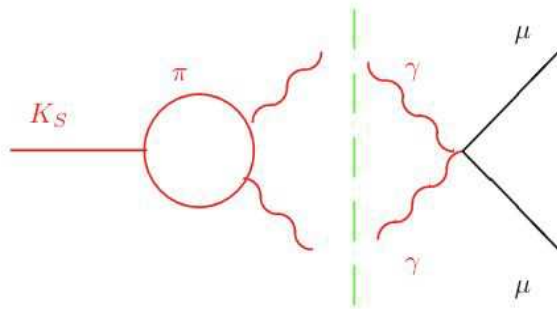
Giancarlo D'Ambrosio
INFN-Sezione di Napoli

Workshop on the Long Term Strategy of INFN-CSN1, Elba, 22h
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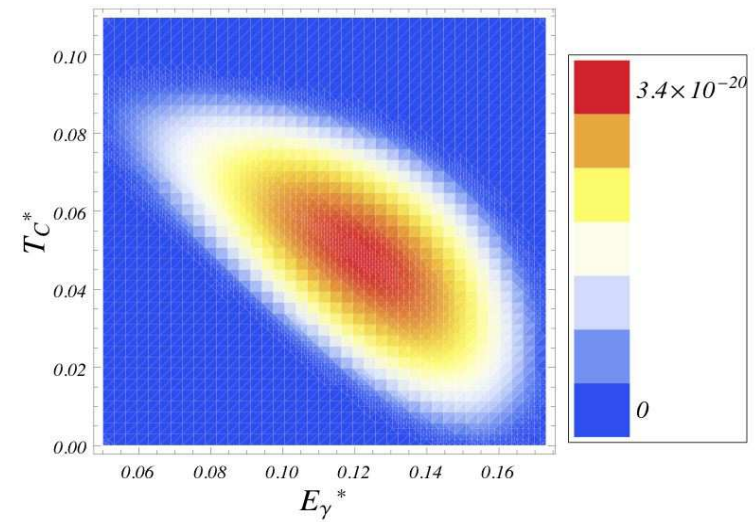
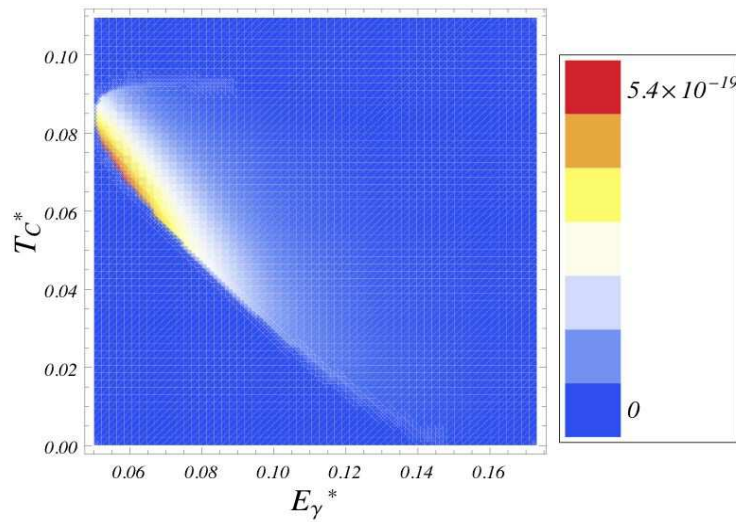
- $K^+ \rightarrow \pi^+ \pi^0 e^+ e^-$, $K_S \rightarrow \pi^+ \pi^- \mu^+ \mu^-$
- $K_S \rightarrow \mu^+ \mu^-$, $K^+ \rightarrow \pi^+ \mu^+ \mu^-$ and related channels

$$K_S \rightarrow \mu \bar{\mu}$$

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



q_c (MeV)	B [10^{-8}]	B/M	B/E	B/BE	B/BM
$2m_l$	418.27	71	4405	128	208
55	5.62	12	118	38	44
100	0.67	8	30	71	36
140	0.04	9	10	-45	37
180	0.003	12	5	-19	44



$$K_S \rightarrow \pi^+ \pi^- e^+ e^- \text{ and } K_S \rightarrow \pi^+ \pi^- \mu^+ \mu^-$$

$$BR(K_S \rightarrow \pi^+ \pi^- e^+ e^-)_B = 4.73 \times 10^{-5}$$

$$BR(K_S \rightarrow \pi^+ \pi^- e^+ e^-)_{BE} = 2.68 \times 10^{-8}$$

$$BR(K_S \rightarrow \pi^+ \pi^- e^+ e^-)_E = 6.82 \times 10^{-11}$$

The branching ratio of the Brehmsstrahlung is very close to the PDG value

$$BR(K_S \rightarrow \pi^+ \pi^- e^+ e^-)_{PDG} = (4.79 \pm 0.15) \times 10^{-5}$$

$K_S \rightarrow \pi^+ \pi^- \mu^+ \mu^-$ 7.15 MeV phase space

$$BR(K_S \rightarrow \pi^+ \pi^- \mu^+ \mu^-)_B = 4.17 \times 10^{-14}$$

$$BR(K_S \rightarrow \pi^+ \pi^- \mu^+ \mu^-)_{BE} = 4.40 \times 10^{-15}$$

$$BR(K_S \rightarrow \pi^+ \pi^- \mu^+ \mu^-)_E = 1.16 \times 10^{-16}$$

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