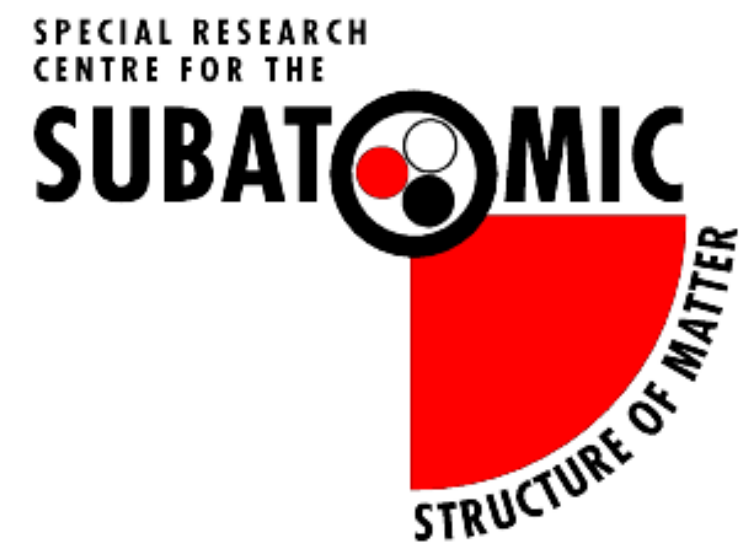


Feynman-Hellmann determination of $K \rightarrow \pi$ transition matrix elements

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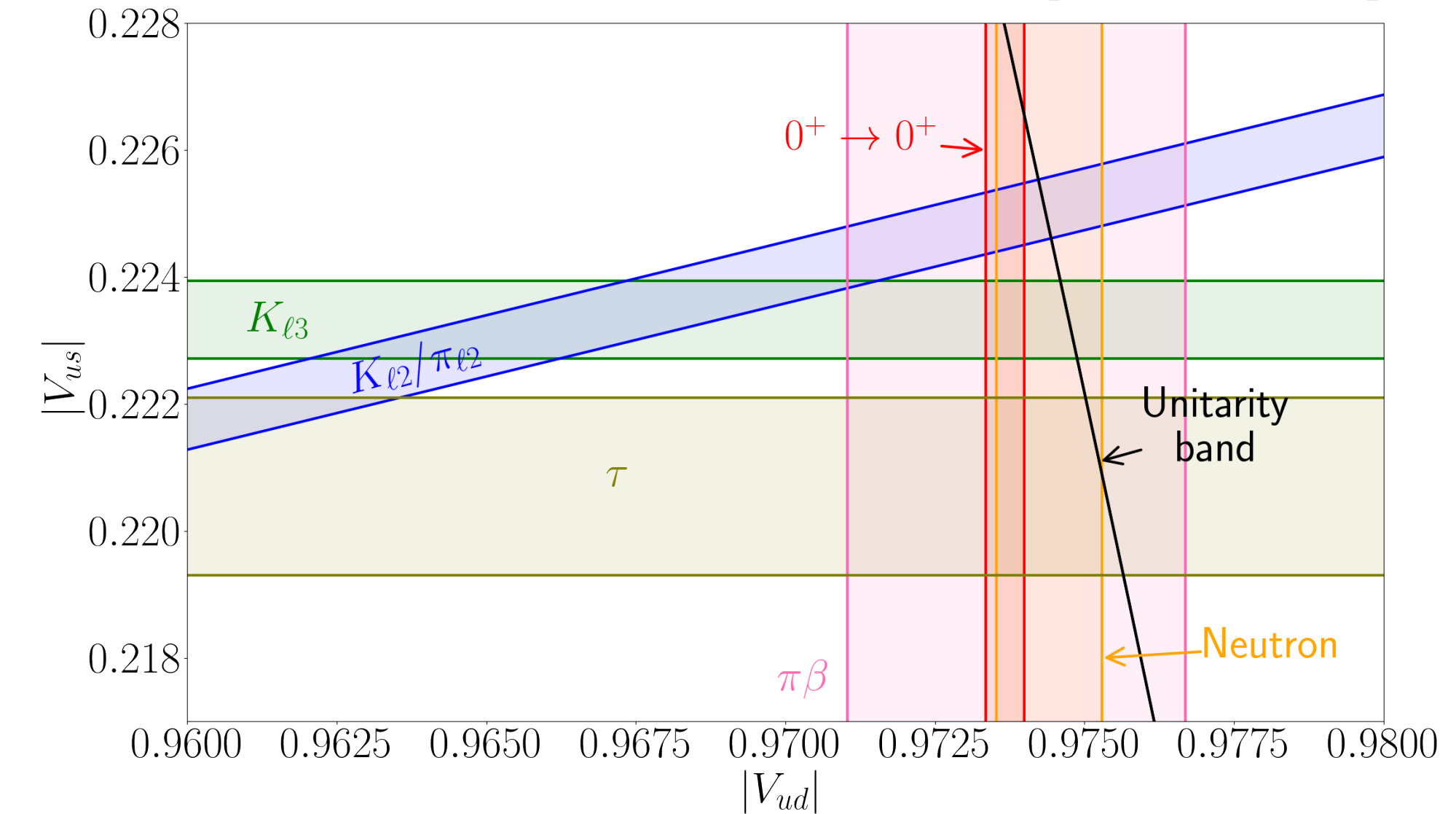
$K^0 \rightarrow \pi^- \ell^+ \nu_\ell$ Transitions

- Semileptonic kaon decays ($K_{\ell 3}$) are important for constraining V_{us}

$$\Gamma_{K_{\ell 3}} \propto |V_{us}|^2 |f_+^{K\pi}(0)|^2 I_{K\ell} \times (1 + \delta EM + \delta_{SU(2)})$$

- Experiment determines $|V_{us}| f_+(0)$
 - Lattice QCD determinations of $f_+^{K\pi}(0)$ are required for good estimates of $|V_{us}|$
- The required precision for $f_+(0)$ makes excited state contributions and kinematic systematics important

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First row CKM unitarity

$$|V_{ud}|^2 + |V_{us}|^2 + |V_{ub}|^2 = 1$$

