Problem 1: Unitarity

Show that the CKM matrix is unitary for any real number $\theta_{12}$, $\theta_{23}$, $\theta_{13}$, and $\delta$, i.e. show that $(VV^\dagger)_{11} = 1$ and $(VV^\dagger)_{12} = 0$ and so on.

\[
VV^\dagger = \begin{pmatrix}
-c_{12}c_{13} & s_{12}c_{13} & s_{13}e^{-i\delta} \\
-s_{12}c_{23} - c_{12}s_{23}s_{13}e^{i\delta} & c_{12}c_{23} - s_{12}s_{23}s_{13}e^{i\delta} & s_{23}c_{13} \\
-s_{12}c_{23} - s_{12}s_{23}s_{13}e^{-i\delta} & -c_{12}c_{23} - s_{12}s_{23}s_{13}e^{-i\delta} & c_{23}c_{13}
\end{pmatrix}
\]

\[
\times \begin{pmatrix}
c_{12}c_{13} & s_{12}c_{13} & s_{13}e^{i\delta} \\
-s_{12}c_{23} - c_{12}s_{23}s_{13}e^{-i\delta} & c_{12}c_{23} - s_{12}s_{23}s_{13}e^{-i\delta} & s_{23}c_{13} \\
-s_{12}c_{23} - s_{12}s_{23}s_{13}e^{i\delta} & -c_{12}c_{23} - s_{12}s_{23}s_{13}e^{i\delta} & c_{23}c_{13}
\end{pmatrix}
\]

Problem 2: CKM Parameter

Show that as long as the CKM matrix is unitary, the GIM mechanism for eliminating $K^0 \rightarrow \mu^+\mu^-$ works for three generations or any number of generations. Note: $u \rightarrow d + W^+$ carries a CKM factor $V_{ud}$ and $d \rightarrow u + W^-$ carries a factor $V^*_{ud}$.
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