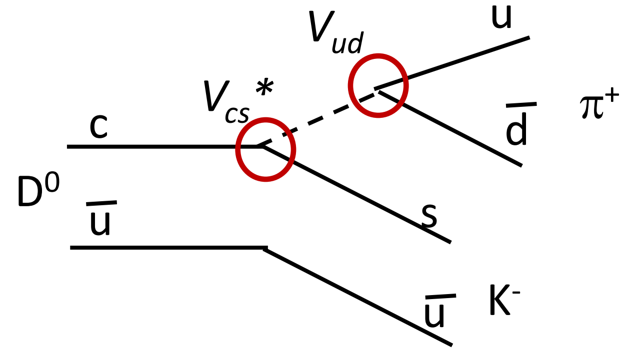
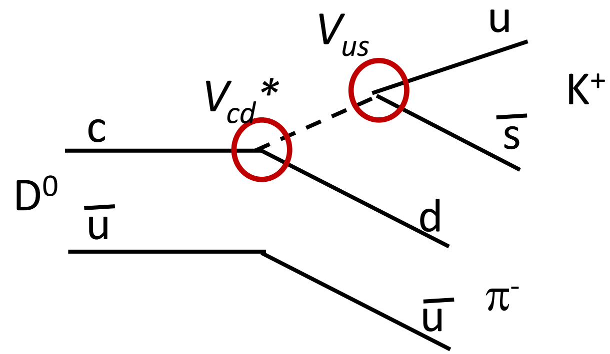
Cabibbo-Kobayashi-Maskawa Matrix

$$\begin{bmatrix} |d'\rangle \\ |s'\rangle \\ |b'\rangle \end{bmatrix} = \begin{bmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{bmatrix} \begin{bmatrix} |d\rangle \\ |s\rangle \\ |b\rangle \end{bmatrix}.$$



$\mathcal{M} \propto V_{cs}{}^{*} V_{ud}$



$\mathcal{M} \propto V_{cd}{}^{*} V_{us}$

Wolfenstein parametriz.:

$$V_{CKM} = \begin{bmatrix} 1-\lambda^2/2 & \lambda & A\lambda^3(\rho - i\eta) \\ -\lambda & 1-\lambda^2/2 & A\lambda^2 \\ A\lambda^3(1-\rho-i\eta) & -A\lambda^2 & 1 \end{bmatrix} + O(\lambda^4)$$

$\lambda \approx 0.225$

Cabibbo-Kobayashi-Maskawa Matrix:

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CP-Violation in the Renormalizable Theory of Weak Interaction

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In a framework of the renormalizable theory of weak interaction, problems of *CP*-violation are studied. It is concluded that no realistic models of *CP*-violation exist in the quartet scheme without introducing any other new fields. Some possible models of *CP*-violation are also discussed.

⋮

⋮

i) *Case* (A, C)

This is the most natural choice in the quartet model. Let us denote two $(SU_{weak}(2))$ doublets and four singlets by L_{d1}, L_{d2}, $R_{s1}^{(p)}$, $R_{s2}^{(p)}$, $R_{s1}^{(n)}$ and $R_{s2}^{(n)}$, where superscript $p(n)$ indicates p-like (n-like) charge states. In this case, $\mathcal{L}_{mass}$ takes, in general, the following form:

$$\mathcal{L}_{mass} = \sum_{i,j=1,2} [M_{ij}^{(n)} \bar{L}_{di} \varphi R_{sj}^{(n)} + M_{ij}^{(p)} \bar{L}_{di} \varepsilon \varphi^* R_{sj}^{(p)}] + \text{h.c.},$$

$$\varphi^* \equiv \begin{pmatrix} \varphi^- \\ \bar{\varphi}^0 \end{pmatrix}, \qquad \varepsilon \equiv \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}, \tag{1}$$

⋮

iv) *Case* (A, A)

In a similar way, we can show that no *CP*-violation occurs in this case as far as $\mathcal{L}' = 0$. Furthermore this model would reduce to an exactly $U(4)$ symmetric one.

⋮

$$\begin{pmatrix} \cos\theta_1 & -\sin\theta_1\cos\theta_3 & -\sin\theta_1\sin\theta_3 \\ \sin\theta_1\cos\theta_2 & \cos\theta_1\cos\theta_2\cos\theta_3 - \sin\theta_2\sin\theta_3 e^{i\delta} & \cos\theta_1\cos\theta_2\sin\theta_3 + \sin\theta_2\cos\theta_3 e^{i\delta} \\ \sin\theta_1\sin\theta_2 & \cos\theta_1\sin\theta_2\cos\theta_3 + \cos\theta_2\sin\theta_3 e^{i\delta} & \cos\theta_1\sin\theta_2\sin\theta_3 - \cos\theta_2\sin\theta_3 e^{i\delta} \end{pmatrix}. \tag{13}$$

M. Kobayashi, T. Maskawa, 1973:

$$\begin{bmatrix} d' \\ s' \\ b' \end{bmatrix} = \underline{V_{CKM}} \begin{bmatrix} d \\ s \\ b \end{bmatrix}$$

Nobel Prize for Physics in 2008

2008