The evaluation of V_{ud} and its impact on the unitarity of the Cabbibo-Kobayashi-Maskawa quark-mixing matrix

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We have written an invited review article [1] on the determination of the Cabibbo-Kobayashi-Maskawa (CKM) matrix element V_{ud}. Data from $0^+ \rightarrow 0^+$ superallowed beta decay in nuclei, neutron decay, beta decay of odd-mass mirror nuclei and pion decay were considered. Theoretical radiative and isospin symmetry-breaking corrections were applied. The most precise result comes from the nuclear $0^+ \rightarrow 0^+$ decays, which yield a recommended value of $|V_{ud}| = 0.97425(22)$. We further summarized the data leading to the CKM matrix element V_{us}: K_{l3} and K_{l2} decays, hyperon decays and hadronic tau decay. Again radiative corrections and $SU(3)$-symmetry breaking corrections (from lattice QCD) were applied. We adopted values from K_{l3} decay of $|V_{us}| = 0.2246(12)$ and from K_{l2} decay of $|V_{us}/V_{ud}| = 0.2319(14)$. From the three data just cited, a least-squares fit determines two CKM matrix elements: $|V_{ud}| = 0.97425(22)$ and $|V_{us}| = 0.22521(94)$. Data leading to the third member of the top row of the CKM matrix, V_{ub}, were summarized as well but, being of order 10^{-3}, that matrix element contributes negligibly to the unitarity sum, $|V_{ud}|^2 + |V_{us}|^2 + |V_{ub}|^2$. We found this sum to be 0.99990(60), showing unitarity to be satisfied to a precision of 0.06%. We also discussed the constraints that this result places on several selected extensions to the standard model.

[1] I.S. Towner and J.C. Hardy, Rep. Prog. Phys. **73**, in press.