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# Lattice QCD Calculation of Electroweak Box Contributions to Superallowed Nuclear and Neutron Beta Decays

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We present the first lattice QCD calculation of the universal axial $\gamma W$-box contribution $square_{\gamma W}^{VA}$ to both superallowed nuclear and neutron beta decays.
This contribution emerges as a significant component within the theoretical uncertainties surrounding the extraction of $|V_{ud}|$ from superallowed decays.
Our calculation is conducted using two domain wall fermion ensembles at the physical pion mass.
To construct the nucleon 4-point correlation functions, we employ the random sparsening field technique.
Furthermore, we incorporate long-distance contributions to the hadronic function using the infinite-volume reconstruction method.
Upon performing the continuum extrapolation, we arrive at
$square_{\gamma W}^{VA} = 3.65(8)_{\text{lat}}(1)_{\text{PT}} \times 10^{-3}$. Consequently, this yields a slightly higher value of $|V_{ud}| = 0.97386(11)_{\text{exp.}}(9)_{\text{RC}}(27)_{\text{NS}}$, reducing the previous $2.1\sigma$ tension with the CKM unitarity to $1.8\sigma$.
Additionally, we calculate the vector $\gamma W$-box contribution to the axial charge $g_A$, denoted as $square_{\gamma W}^{VV}$, and explore its potential implications.

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