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First-principles calculation of electroweak box diagrams from lattice QCD

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We present the first realistic lattice QCD calculation of the γW-box diagrams relevant for beta decays. The nonperturbative low-momentum integral of the γW loop is calculated using a lattice QCD simulation, complemented by the perturbative QCD result at high momenta. Using the pion semileptonic decay as an example, we demonstrate the feasibility of the method. By using domain wall fermions at the physical pion mass with multiple lattice spacings and volumes, we obtain the axial γW-box correction to the semileptonic pion decay, □γWVA|π=2.830(11)stat(26)sys×10−3, with the total uncertainty controlled at the level of ~1%. This study sheds light on the first-principles computation of the γW-box correction to the neutron decay, which plays a decisive role in the determination of |Vud|.

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