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Study of the Λ → pℓν¯ℓ semileptonic decay in lattice QCD

We present the first lattice QCD determination of the Λ → N vector and axial-vector form factors, which are essential inputs for studying the semileptonic decay Λ → pℓν¯ℓ. This channel provides a clean, heoretically controlled avenue for extracting the CKM matrix element |Vus| from the baryon sector. Our analysis uses a gauge ensemble with physical light, strange, and charm quark masses and yields the most precise determination to date of the full set of transition form factors—including second-class contributions—as well as the associated couplings, radii, and the ratio of muon-toelectron decay rates, an observable sensitive to possible non-standard scalar and tensor interactions.

We compare our non-perturbative results with next-to-next-to-leading order expansions in the small parameter δ = (mΛ − mN)/mΛ ≈ 0.16. We find that the common phenomenological approximation of neglecting the q2-dependence of the form factors leads to a ∼ 4% deviation in the decay rate.

This underscores the critical importance of precise, fully non-perturbative form factor inputs for achieving the sub-percent precision targets of upcoming experimental programs.

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