Baryon Weak Decays —From Experiments to Lattice QCD

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Book of Abstracts

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Study of the $\Lambda \to p\ell\bar{v}_\ell$ semileptonic decay in lattice QCD

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We present the first lattice QCD determination of the $\Lambda \to N$ vector and axial-vector form factors, which are essential inputs for studying the semileptonic decay $\Lambda \to p\ell\bar{\nu}_\ell$. This channel provides a clean, theoretically controlled avenue for extracting the CKM matrix element $|V_{us}|$ 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 $\delta = (m - m_N)/m \approx 0.16$. We find that the common phenomenological approximation of neglecting the q^2-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.