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Radiative decays of charged leptons as constraints of leptonic unitarity

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We calculate the rates of radiative $\beta^- \rightarrow \alpha^- + \gamma$ decays for $(\alpha, \beta) = (e, \mu), (e, \tau)$ and (μ, τ) by taking the {it unitary} gauge in the $(3 + n)$ active-sterile neutrino mixing scheme, and make it clear that constraints on the unitarity of the 3×3 Pontecorvo-Maki-Nakagawa-Sakata (PMNS) matrix U extracted from $\beta^- \rightarrow \alpha^- + \gamma$ decays in the {it minimal unitarity violation} scheme differ from those obtained in the canonical seesaw mechanism with n heavy Majorana neutrinos by a factor $5/3$. In such a natural seesaw case we show that the rates of $\beta^- \rightarrow \alpha^- + \gamma$ can be used to cleanly and strongly constrain the effective apex of a unitarity polygon, and compare its geometry with the geometry of its three sub-triangles formed by two vectors $U_{\alpha i} U_{\beta i}^*$ and $U_{\alpha j} U_{\beta j}^*$ (for $i \neq j$) in the complex plane. We find that the areas of such sub-triangles can be described in terms of the Jarlskog-like invariants of CP violation $\text{cal} J_{\alpha\beta}^{ij}$, and their small differences signify slight unitarity violation of the PMNS matrix U .

Collaboration name

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