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Radiative decays of charged leptons as constraints of leptonic unitarity

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We calculate the rates of radiative $\beta^- \to \alpha^- + \gamma$ decays for $(\alpha, \beta) = (e, \mu)$, (e, τ) 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 $\beta^- \to \alpha^- + \gamma$ 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 $\beta^- \to \alpha^- + \gamma$ 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 $calJ^{ij}_{\alpha\beta}$, and their small differences signify slight unitarity violation of the PMNS matrix U.

Collaboration name

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