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Study of Neutrinoless Double Beta Decay in Standard Model extended with Sterile Neutrinos

The existence of non-interacting fermion singlets, known as sterile neutrinos, is contextualized in beyond Standard Model physics. They have become a key element in various scenarios, ranging from explaining oscillation anomalies to accounting for the neutrino mass generation mechanism via the type-I seesaw. Motivated by this, we study a model in which the Standard Model is augmented with three sterile neutrino states. For the mixing matrix of active and sterile neutrinos, we adopt a particular parametrization of a (6×6) unitary matrix. In this context, we derived the masses of the added sterile states analytically using the exact seesaw relation in terms of active-active and active-sterile mixing angles and CP-violating phases. As both active and sterile states can mediate the neutrinoless double beta decay ($0\nu\beta\beta$) process, their contributions to the effective mass of the electron neutrino,
$lvertm_{ee}$
$rvert$, become a function of the mass of the lightest active neutrino state and active-active and active-sterile mixing angles and phases. We explore the parameter space of
$lvertm_{ee}$
$rvert$, keeping in mind the present and future sensitivity of $0\nu\beta\beta$ decay searches. By incorporating constraints from charged lepton flavor violation (cLFV) processes and non-unitarity, we examined the impact of additional CP-violating phases and values of active-sterile mixing angles. The numerical values thus obtained for
$lvertm_{ee}$
$rvert$ can vary from as low as $\mathcal{O}(10^{-4})$ to saturating the present experimental limit. To validate our findings, we also assessed the branching ratio of $\mu \to e\gamma$, a significant cLFV process, and considered non-unitarity implications within this theoretical framework.

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