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Probing Neutrino-philic Scalars in Muon and Double Beta Decay

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Self-interacting neutrinos are well-motivated particles in order to solve problems such as Hubble tension in cosmology. Neutrino-philic scalars, such as flavons and Majorons, can be solutions to BSM puzzles, such as lepton number and lepton flavour violations. New muon decay channels (e.g. $\mu \longrightarrow e\phi$, $\mu \longrightarrow e\phi\phi$) will be introduced by neurtino-scalar couplings and $\mu \longrightarrow e\nu\nu$ will have additional contribution from scalar one-loop effect. Scalar-facilitated neutrino self-interaction can also contribute to two-neutrino double beta decay, the shape of the two-electron spectrum in double beta decay experiments can therefore be modified. The interference between SM and scalar facilitated diagrams will enhance the sensitivity to new physics when the final state particles are the same as SM process. These new channels and enhancements will lead to a wider neurtino-scalar coupling parameter space that can be tested in future experiments.

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