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Charged lepton flavor violating decays $Z \to \ell_\alpha \ell_\beta$ in the inverse seesaw

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After confirmation of the massiveness and mixing of neutrinos, by neutrino oscillation data, the origin of neutrino mass and the occurrence of charged-lepton-flavor non-conservation in nature have become two main objectives for the physics of elementary particles. Taking inspiration from these two matters, we address the Z-boson lepton decays $Z \to \ell_\alpha \ell_\beta$, with $\ell_\alpha \neq \ell_\beta$, thus violating charged-lepton flavor. We calculate the set of contributing one-loop Feynman diagrams characterized by virtual neutral leptons, both light and heavy, emerged from the inverse seesaw mechanism for the generation of neutrino mass. We obtain general analytical results, which decouple in the limit as $\Lambda \to \infty$, with Λ the high-energy scale involved in the inverse seesaw mechanism. Our quantitative analyses consider two scenarios of heavy-neutral-lepton mass: (1) the mass spectrum is degenerate; and (2) a more complete framework which includes both degenerate and non-degenerate mass spectra. The quantitative estimations we perform in both scenarios take into account upper bounds on non-unitarity deviations in the lepton mixing matrix and perturbativity of Yukawa couplings. We find that, even though current constraints on $Z \to \ell_\alpha \ell_\beta$, by the ATLAS Collaboration, remain far from inverse-seesaw contributions, improved sensitivity from in-plans machines, such as the Future Circular Collider and the Circular Electron Positron Collider, shall be able to probe this mass-generating mechanism through the decay $Z \to \tau e$, whose contributions could be as large as 10^{-7}.

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