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Axion-like Particles and Lepton-Flavor Violation

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Axion-like Particles (ALPs) appear in many well-motivated extensions of the Standard Model. We present a detailed study of the phenomenology of ALPs with lepton flavor-violating couplings. Studied observables include rare LFV decays of muons and taus, non-decay experiments such as the electron and muon electric dipole moment (EDM) and muonium oscillations, and as well the effect flavor-violating ALP-couplings could have on the long-lasting discrepancy between Standard Model expectation value and measurement in $(g-2)_\mu$. We highlight that for ALPs that can be resonantly produced, the sensitivity of three-body decays such as $\mu \to 3e$ and $\tau \to 3\mu$ exceeds by many orders of magnitude that of radiative decays like $\mu \to e\gamma$ and $\tau \to \mu\gamma$. Searches for these two types of processes are therefore highly complementary.

We derive bounds on LFV ALP couplings in dependence of the ALP mass and consistently take lifetime-effects and experimental features like detector geometry and experimental timing cuts into account. Our results are presented in benchmark-scenarios where only one LFV coupling is present at a time.

Keywords: Axion-like Particles, ALP, Lepton-Flavor Violation

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