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Probing the L_μ-L_τ Gauge Boson at the MUonE Experiment

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We discuss the prospects of probing the $L_\mu - L_\tau$ gauge boson at the MUonE experiment. The $L_\mu - L_\tau$ gauge boson Z' with a mass of < 200 MeV, which can explain the discrepancy between the measured value of the muon $g-2$ and the value calculated in the Standard Model, can be produced at the MUonE experiment through the process $\mu e \to \mu e Z'$. The Z' in the final state decays into a pair of neutrinos, and therefore we cannot observe the decay of Z' directly. It is, however, still possible to probe this signature by searching for events with a large scattering angle of muon and a less energetic final-state electron. The background events coming from the elastic scattering $\mu e \to \mu e$ as well as radiative process $\mu e \to \mu e \gamma$ can be removed by the kinematical cuts on the muon scattering angle and the electron energy, in addition to a photon veto. The background events from the electroweak process $\mu e \to \mu e \nu \bar{\nu}$ are negligible. With our selection criteria, the number of signal events $\mu e \to \mu e Z'$ is found to be as large as $\sim 10^3$, assuming an integrated luminosity of 15 fb^{-1}, in the parameter region motivated by the muon $g-2$ discrepancy. It is, therefore, quite feasible to probe the $L_\mu - L_\tau$ gauge boson at the MUonE experiment—without introducing additional devices—and we strongly recommend recording the events relevant to this Z' production process.

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