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Muon collider signatures for a Z' with a maximal $\mu - \tau$ coupling in $U(1)_{L_\mu - L_\tau}$

The gauged $U(1)_{L_\mu - L_\tau}$ model is a candidate model for explaining the muon g-2 anomaly because the Z' in the model has a natural normal coupling to muon. Due to other experimental data constraints the viable mass range for the usual Z' is constrained to be lower than a few hundred MeV. It has been shown that if the Z' has a maximal off-diagonal mixing, $(\bar{\mu}\gamma^\mu\tau + \bar{\tau}\gamma^\mu\mu)Z'_\mu$, a large mass for Z' is possible. This class of models has a very interesting signature for detection, such as $\mu^-\mu^+ \to \tau^-\tau^+$ pair, $\mu^-\mu^+ \to \mu^\pm\mu^\pm\tau^\mp\tau^\mp$ at a muon collider. In this work we study in detail these processes. We find that the in the parameter space solving the muon g-2 anomaly, t-channel $\tau^-\tau^+$ pair production can easily be distinguished at more than 5σ level from the s-channel production as that predicted in the standard model. The smoking gun signature of doubly same sign $\mu^\pm\mu^\pm + \tau^\mp\tau^\mp$ pairs production can have a 5σ sensitivity, at a muon collider of 3 TeV with $\mathcal{O}(fb^{-1})$ luminosity.

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