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Constraints on lepton-flavor-violating scalar portal using the Belle II result in the search for

$$e^+e^- \rightarrow e^\pm\mu^\mp + \text{invisible with } \text{cal L} = 276 \text{ pb}^{-1}$$

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Lepton-flavor-violating (LFV) scalar portal is an interesting mechanism that connects the dark sector to the visible one. This mechanism leads to a rich phenomenology including an extra contribution to muon anomalous magnetic moment desirable for alleviating the discrepancy between the updated SM prediction and the combined results of Fermilab and BNL measurements. With the low-energy effective coupling $\text{cal}L_{\phi\mu e} = -y_{\mu e} (\bar{e}_L\mu_R\phi + \bar{\mu}_Re_L\phi^*)$, which turns muon into electron or vice versa through the scalar ϕ , we derive the $(y_{\mu e}, m_\phi)$ parameter space that could account for the discrepancy mentioned above. Furthermore, we calculate the cross section $e^+e^- \rightarrow e^-\mu^+\phi^*, e^+\mu^-\phi$ induced by $\text{cal}L_{\phi\mu e}$ and SM vertices. Using Belle II model-independent 90% C.L. upper limit on ε (efficiency) $\times \sigma(e^+e^- \rightarrow e^\pm\mu^\mp + \text{invisible})$ with $\text{cal L} = 276 \text{ pb}^{-1}$ (Phys. Rev. Lett. **124**, 141801 (2020)), we obtain the corresponding upper limit for $y_{\mu e} \times \sqrt{\varepsilon \cdot \text{Br}(\phi \rightarrow \text{invisible})}$. For $\varepsilon = 1\%$ and $\text{Br}(\phi \rightarrow \text{invisible}) = 1$, we found that for $m_\phi < 4 \text{ GeV}$, the 90% C.L. upper limit for $y_{\mu e}$ is already in the favorable parameter range to account for the measured $g_\mu - 2$.

We stress that explicit details of scalar portal models would determine $\text{Br}(\phi \rightarrow \text{invisible})$ while the efficiency factor ε requires a detailed experimental analysis. Here we meant to point out that the search for $e^+e^- \rightarrow e^\pm\mu^\mp + \text{invisible}$ could yield very interesting constraints on LFV scalar portal models. Hence a model-dependent experimental analysis is also very worthwhile.

In-person participation

Yes

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