

Sensitivity of the $\eta^{(\prime)} \rightarrow \pi^0 \gamma \gamma$ and $\eta' \rightarrow \eta \gamma \gamma$ decays to a sub-GeV leptophobic $U(1)_B$ boson

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The sensitivity of the rare decays $\eta^{(\prime)} \rightarrow \pi^0 \gamma \gamma$ and $\eta' \rightarrow \eta \gamma \gamma$ to signatures of a leptophobic B boson in the MeV-GeV mass range is analyzed in this work.

By adding an explicit B -boson resonance exchange, $\eta \rightarrow B \gamma \rightarrow \pi^0 \gamma \gamma$, to the Standard Model contributions from vector and scalar meson exchanges, and employing experimental data for the associated branching ratios, it allows us to improve the current constraints on the B -boson mass m_B and coupling to Standard Model particles α_B .

From these constraints and the analysis of the available experimental $\gamma \gamma$ invariant mass distribution, we show that a B -boson signature in the resonant mass range $m_{\pi^0} \leq m_B \leq m_{\eta'}$ is strongly suppressed and would be very difficult to experimentally identify, assuming that the leptophobic B boson only decays to Standard Model particles.

In contrast, the limits outside this mass window are less stringent and the corresponding t - and u -channel signatures may still be observable in the data, as it occurs with the nonresonant Standard Model ρ , ω and ϕ meson exchanges.

In addition, we make use of experimental data from the $\eta' \rightarrow \pi^0 \gamma \gamma$ and $\eta' \rightarrow \eta \gamma \gamma$ decays to explore larger B -boson masses.

Our results are relevant for the B -boson search programs at existing and forthcoming light-meson facilities, such as KLOE(-II) and Jefferson Lab Eta Factory experiments.

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