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Long-lived heavy neutral leptons from axionlike particles at the LHC and Belle II

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In hidden-sector models, axion-like particles (ALPs) can couple to heavy neutral leptons (HNLs), leading to rich phenomenologies. We study ALPs produced from D- and B-meson decays via quark-favor-violating couplings, and decaying exclusively into a pair of HNLs which mix with active neutrinos. The ALP can be either short- or long-lived, depending on the masses of the ALP and the HNL, as well as the corresponding coupling strength. Such GeV-scale HNLs are necessarily long-lived given the current bounds on their mixing parameters. We assess the sensitivities of the LHC far detectors, SHiP, and Belle II, to the long-lived HNLs in such theoretical scenarios. We fnd that for currently allowed values of the ALP couplings, most of the LHC experiments can probe the active-sterile-neutrino mixing parameters multiple orders of magnitude beyond the present bounds, covering large parameter region targeted with the type-I seesaw mechanism, while the Belle II experiment can test the mixing parameters up to two orders of magnitude below the existing limits.

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