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A baryon and lepton number violation model testable at the LHC

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Proton decay experiments typically constrain baryon number violation to the scale of grand unified theories. From a phenomenological point of view, this makes direct probing of the associated new resonances, such as the X and Y bosons, out of reach for even the most optimistic future experiments. It has, however, been known that certain specific patterns of baryon and lepton number violation can suppress proton decay by multiple powers of the masses of the heavy resonances involved, opening the possibility that the observed limits on the proton lifetime are consistent with baryon number violating physics at energy scales much lower than that of grand unification. We construct an explicit example of such a model which violates baryon number by one unit, $\Delta \mathrm{B} = -1$, and lepton number by three units, $\Delta \mathrm{L} = -3$, and show that despite stringent limits on the predicted $p \to e^+/\mu^+\overline{\nu}\overline{\nu}$ mode from the Super-Kamiokande experiment, the masses of the newly introduced elementary particles can be $\mathcal{O}$(TeV). We identify interesting unique signatures of baryon number violation of this model that can be probed both with currently available LHC data and with the upcoming High-Luminosity LHC. We also present a scenario for low-scale baryogenesis within the framework of this model.

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