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Dirac vs. Majorana HNLs (and their oscillations) at SHiP

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SHiP is a proposed high-intensity beam dump experiment set to operate at the CERN SPS. It is expected to have an unprecedented sensitivity to a variety of models containing feebly-interacting particles, such as Heavy Neutral Leptons (HNLs). Two HNLs or more could successfully explain the observed neutrino masses through the seesaw mechanism. If, in addition, they are quasi-degenerate, they could be responsible for the baryon asymmetry of the Universe. Depending on their mass splitting, HNLs can have very different phenomenologies, e.g. they can behave either as Dirac or Majorana fermions. In this work, we consider the possibility of distinguishing Dirac and Majorana HNLs at SHiP. This requires being able to discriminate between lepton number conserving and violating decays in a beam dump setting. We show, both analytically and numerically, that this can be achieved by looking at the angular distribution of the visible HNL decay products. SHiP will thus be able to tell apart Dirac from Majorana HNLs in a significant region of parameter space, unconstrained by current or upcoming experiments. Even better, it may be able to resolve their coherent oscillations, hence providing a direct measurement of the mass splitting!

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