

## The neutrinoless beta beta process at the LHC and beyond

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The Majorana nature of neutrinos and whether lepton number symmetry is conserved are among the most pressing mysteries in physics today. This follows from their widespread implications for cosmology, nuclear physics, and particle physics. Along these lines, searches for the neutrinoless beta beta ( $0\nu\text{BB}$ ) decay mode of heavy nuclei are highly sensitive probes of these questions, albeit with important limitations. In this talk we present a new look into the high-energy realization of the  $0\nu\text{BB}$  process at the Large Hadron Collider (LHC). As a case study, we focus on the same-sign  $WW$  scattering process to same-sign muons, which violates lepton number and is outside the reach of nuclear decay experiments. Whether mediated by heavy Majorana neutrinos or more generally by the Weinberg operator, we find that the LHC offers incredible complementarity to lower energy experiments and further extends the sensitivity to the nature of neutrinos.

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