Resonant Production of Scalar Leptons by RPV Couplings at the FCC

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ABSTRACT

Resonant production of and at the FCC-pp has been considered. For example, scalar neutrino may be investigated through subprocess . These processes have great potential for determination of RPV couplings.

INTRODUCTION

Supersymmetry (SUSY) predicts a new bosonic (fermionic) partner for each fundamental Standard Model (SM) fermion (boson) as well as an additional Higgs doublet. These new particles can be scalar particles known as squarks and sleptons. They are carry baryon (B) or lepton (L) quantum numbers, potentially leading to interactions violating B or L conservation [1, 2].

R-parity quantum number defined as , where SM particles have R-parity quantum number and Supersymmetric particles have R-odd quantum number. R-parity violation (RPV) interactions have rich phenomenological potential [1]. In this work, we studied resonant production of stau-neutrino by RPV violation interactions (pp collisions by annihilation and subsequently decay to final state) at the Future Circular Collider (FCC).

RPV interaction Lagrangian for slepton are given below [1]:

Where L and Q are SU(2) doublet superfields of leptons and quarks; and are the SU(2) singlet superfields of leptons and downlike quarks; and are Yukawa couplings; and the indices i, j, and k denote fermion generations. Direct decays of sleptons via trilinear operators are given Table I.

Table I. Direct decays of sleptons via trilinear 6Rp operators  and  and .

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PRODUCTION AND DECAYS

2a. sleptons

Figure 1. Resonant production followed by RPV decays (Dark circle denotes RPV vertices.)

2b. Neutrinos

Figure 2. Most spectacular signature for (Dark circle denotes RPV vertices.).

Figure 3. Resonant production followed by RPV decays (Dark circle denotes RPV vertices.).

Final state similar to but in and final states is absent. Again can be differentiate from because of different distributions of final particles.

Most spectacular signature [5, 6]:

Figure 4. Most spectacular signature for (Dark circle denotes RPV vertex.).

PROCESS EXAMPLE

This process is analyzed both at ATLAS [5, 6] and CMS [7]. Using and ATLAS obtain . Using extrapolation framework [8] one can estimate that LHC will cover up to 5.0 TeV with .

For numerical calculations we use CompHEP simulation program [9-11] in Figure 5 we present partial decay widths for and .

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Figure 5. Partial decay widths of (up) and (down). Cross-sections for the process under consideration is given in Figure 6.

CONCLUSION

We investigated resonant production of stau-neutrino by RPV interaction at the FCC-hh collider. As a result of our calculations, if , FCC will give opportunity for discovery of stau-neutrino up to 18.1 TeV, observation up to 20 TeV and exclusion up to 21.4 TeV with . Large number of RPV coupling constants and parameters still remain unconstrained. That is way FCC will give the opportunity to detail probe RPV coupling and parameters.

ACKNOWLEDGMENTS

This work was supported by the Scientific Research Coordination Unit of Istanbul University, project number BEK-2017-25593.