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Search for supersymmetric partners of electrons and muons in proton–proton collisions at $\sqrt{s} = 13\,\text{TeV}$

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ABSTRACT

A search for direct production of the supersymmetric (SUSY) partners of electrons or muons is presented in final states with two opposite-charge, same-flavour leptons (electrons and muons), no jets, and large missing transverse momentum. The data sample corresponds to an integrated luminosity of 35.9 fb^{-1} of proton–proton collisions at $\sqrt{s} = 13\,\text{TeV}$, collected with the CMS detector at the LHC in 2016. The search uses the M_{T2} variable, which generalises the transverse mass for systems with two invisible objects and provides a discrimination against standard model backgrounds containing W bosons. The observed yields are consistent with the expectations from the standard model. The search is interpreted in the context of simplified SUSY models and probes slepton masses up to approximately 290, 400, and 450 GeV, assuming right-handed only, left-handed only, and both right- and left-handed sleptons (mass degenerate selectrons and smuons), and a massless lightest supersymmetric particle. Limits are also set on selectrons and smuons separately. These limits show an improvement on the existing limits of approximately 150 GeV.

1. Introduction

The standard model (SM) of particle physics provides a description of the fundamental particles and their interactions, and its predictions have been confirmed experimentally with increasing precision over the last several decades. Supersymmetry (SUSY) [1–8], one of the most promising extensions of the SM, addresses several open questions for which the SM has no answer, such as the hierarchy problem and the origin of dark matter. The theory postulates a new fundamental symmetry that assigns to each SM particle a SUSY partner whose spin differs by one half, causing the SUSY partner of an SM fermion (boson) to be a boson (fermion). In addition to stabilising the Higgs boson (H) mass via cancellations between quantum loop corrections including the top quark and its superpartner, SUSY provides a natural dark matter candidate, if R-parity [9] is conserved, in the form of the lightest SUSY particle (LSP), which is assumed to be massive and stable.

SUSY particles (sparticles) that are coloured, the squarks and gluinos, are produced via the strong interaction with significantly larger cross sections than colourless sparticles of equal masses, at the Large Hadron Collider (LHC). However, if the squarks and gluinos are too heavy to be produced at the LHC, the direct production of colourless sparticles, such as the electroweak superpartners (charginos ($\widetilde{\chi}_1^{\pm}$), neutralinos ($\widetilde{\chi}_2^0$), and sleptons ($\widetilde{\ell}$)), would be the dominant observable SUSY process.

Supersymmetric models predict charged sleptons ($\widetilde{\text{e}}_{\text{L}}$, $\widetilde{\mu}_{\text{L}}$, $\widetilde{\tau}_{\text{L}}$, $\widetilde{\text{e}}_{\text{R}}$, $\widetilde{\mu}_{\text{R}}$, $\widetilde{\tau}_{\text{R}}$), the superpartners of the charged left-handed and right-handed SM leptons, which can be produced at proton–proton (pp) colliders in direct electroweak pair production. At sufficiently heavy slepton masses, the sleptons undergo a two-body decay into one of the heavier neutralinos or a chargino, while direct decays to a neutralino LSP are favoured for light slepton masses. This Letter presents a search for directly produced selectrons and smuons ($\widetilde{\text{e}}_{\text{L}}$, $\widetilde{\mu}_{\text{L}}$, $\widetilde{\text{e}}_{\text{R}}$, $\widetilde{\mu}_{\text{R}}$), under the assumption of direct decays $\widetilde{\ell} \to \ell\widetilde{\chi}_1^0$ with 100% branching ratio, as sketched in Fig. 1. The final state contains little or no hadronic activity and provides a clean signature composed of two opposite-charge (OC), same-flavour (SF) leptons

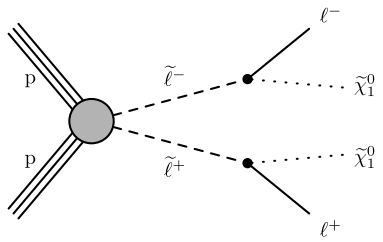

Fig. 1. Diagram of slepton pair production with direct decays into leptons and the lightest neutralino.

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