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A search for new phenomena in pp collisions at $\sqrt{s} = 13$ TeV in final states with missing transverse momentum and at least one jet using the α_{T} variable

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Abstract A search for new phenomena is performed in final states containing one or more jets and an imbalance in transverse momentum in pp collisions at a centre-of-mass energy of 13 TeV. The analysed data sample, recorded with the CMS detector at the CERN LHC, corresponds to an integrated luminosity of 2.3 fb^{-1}. Several kinematic variables are employed to suppress the dominant background, multijet production, as well as to discriminate between other standard model and new physics processes. The search provides sensitivity to a broad range of new-physics models that yield a stable weakly interacting massive particle. The number of observed candidate events is found to agree with the expected contributions from standard model processes, and the result is interpreted in the mass parameter space of fourteen simplified supersymmetric models that assume the pair production of gluinos or squarks and a range of decay modes. For models that assume gluino pair production, masses up to 1575 and 975 GeV are excluded for gluinos and neutralinos, respectively. For models involving the pair production of top squarks and compressed mass spectra, top squark masses up to 400 GeV are excluded.

1 Introduction

The standard model (SM) of particle physics is successful in describing a wide range of phenomena, although it is widely believed to be only an effective approximation of a more complete theory that supersedes it at a higher energy scale. Supersymmetry (SUSY) [1–4] is a modification to the SM that extends its underlying space-time symmetry group. For each boson (fermion) in the SM, a fermionic (bosonic) superpartner, which differs in spin by one-half unit, is introduced.

Experimentally, SUSY is testable through the prediction of an extensive array of new observable states (of unknown masses) [5,6]. In the minimal supersymmetric extension to the SM [6], the gluinos $\widetilde{\mathrm{g}}$, light- and heavy-flavour squarks $\widetilde{\mathrm{q}}$, $\widetilde{\mathrm{b}}$, $\widetilde{\mathrm{t}}$, and sleptons $\widetilde{\ell}$ are, respectively, the superpartners to gluons, quarks, and leptons. An extended Higgs sector is also predicted, as well as four neutralino $\widetilde{\chi}^0_{1,2,3,4}$ and two chargino $\widetilde{\chi}^{\pm}_{1,2}$ states that arise from mixing between the higgsino and gaugino states, which are the superpartners of the Higgs and electroweak gauge bosons. The assumption of R-parity conservation [7] has important consequences for cosmology and collider phenomenology. Supersymmetric particles are expected to be produced in pairs at the LHC, with heavy coloured states decaying, potentially via intermediate SUSY states, to the stable lightest SUSY particle (LSP). The LSP is generally assumed to be the $\widetilde{\chi}^0_1$, which is weakly interacting and massive. This SUSY particle is considered to be a candidate for dark matter (DM) [8], the existence of which is supported by astrophysical data [9]. Hence, a characteristic signature of R-parity-conserving coloured SUSY production at the LHC is a final state containing an abundance of jets, possibly originating from top or bottom quarks, accompanied by a significant transverse momentum imbalance, $\vec{p}_{\mathrm{T}}^{\,\mathrm{miss}}$.

The proposed supersymmetric extension of the SM is also compelling from a theoretical perspective, as the addition of superpartners to SM particles can modify the running of the gauge coupling constants such that their unification can be achieved at a high energy scale [10–12]. A more topical perspective, given the recently discovered Higgs boson [13–15], is the possibility that scale-dependent radiative corrections to the Higgs boson mass from loop processes can be largely cancelled through the introduction of superpartners, thus alleviating the gauge hierarchy problem [16,17]. Alternatively, these radiative corrections can be accommodated through an extreme level of fine tuning of the bare Higgs boson mass. A “natural” solution from SUSY, with minimal fine-tuning, implies that the masses of the $\widetilde{\chi}^0_1$, third-generation squarks, and the gluino are at or near the electroweak scale [18].

The lack of evidence to date for SUSY has also focused attention on regions of the natural parameter space with

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