SEARCHING FOR ELECTROWEAKINO DARK MATTER AT A HADRON COLLIDER

Abstract

by

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Supersymmetry with R parity provides a stable dark matter candidate. However, over much of the parameter space, the dark matter candidate does not freeze out to the observed relic abundance. One method to achieve the observed relic abundance relies on the co-annihilation of multiple, nearly-degenerate electroweakino states. This so-called well tempering evades traditional collider searches because the compressed spectrum leaves soft decay products. I outline new strategies that takes advantage of this compressed spectrum and estimate its usefulness at the LHC and a future 100 TeV collider.

The first strategy is based on final states with missing transverse energy, a photon, and a dilepton pair, $\not{E}_T + \gamma + \ell^+\ell^-$. This search method preforms best when the mass splitting between the heavier neutralinos and the lightest neutralino is less than the Z mass, which is when traditional search strategies break down. Using this new method, I find the LHC could discover a mixed bino-Higgsino with $m_{\tilde{\chi}^0_{2,3}} \lesssim 190$ GeV and $m_{\tilde{\chi}^0_{2,3}} - m_{\tilde{\chi}^0_1} \simeq 30$ GeV with 600 fb^{-1} of 14 TeV data. While the signature of this signal is quite distinct from the backgrounds, triggering is the biggest set-back.

Requiring an additional hard jet from initial (or final) state radiation can provide a trigger at the cost of signal rate. I explore the effects of boosting the electroweakinos off a hard jet at a 100 TeV collider; the background leptons and photons recoil

proportional to the momentum of the jet, while the signal leptons and photons have momentum proportional to the mass splitting. A 100 TeV collider would provide a unique search strategy where one uses the most energetic machine to look for low energy events.

In addition, I also examine an extension to the minimal supersymmetric standard model. This addition adds three $SU(2)_L$ triplet chiral superfields with $Y = 0, \pm 1$ and the superpotential respects a global $SU(2)_L \otimes SU(2)_R$ broken only by the Yukawa interactions. The F terms from these extra fields help raise the mass of the Higgs to the observed value. Meanwhile, if the vacuum mantains the global $SU(2)_L \otimes SU(2)_R$, up to the ratio of the doublet vacuum expectation values, the ρ parameter is protected at tree level. This allows for the triplet scalars to be light which opens the possibility of resonant s-channel funnels to set the observed relic abundance of dark matter. I show over a wide range of parameters that the triplets can help to set the dark matter abundance either through the s-channel funnels or well tempering with the bino.