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Title(English)	Search for direct production of charginos and neutralinos in final states with three leptons and missing transverse momentum in proton-proton collisions at $\sqrt{s}$ = 8 TeV with the ATLAS detector
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論 文 要 旨

THESIS SUMMARY

専攻： Department of	基礎物理学　専攻	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of　（　理学　）
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

Supersymmetry, which introduces a symmetry between bosons and fermions, is a promising candidate for the framework of beyond the Standard Model. It can solve three problems in the Standard Model; the hierarchy problem in the gauge theory, the dark matter, and the deviation of the muon anomalous magnetic moment. Up to now, there is no evidence of supersymmetry reported at LEP, Tevatron, and LHC searches.

In this thesis, a search for direct production of charginos and neutralinos is presented. The analysis is based on $20.3\ \mathrm{fb}^{-1}$ of proton-proton collision data with the centre-of-mass energy of $\sqrt{s} = 8\ \mathrm{TeV}$ delivered by the Large Hadron Collider and recorded with the ATLAS detector in 2012. In this search, the target mode is the direct production of the lightest chargino and the second lightest neutralino, $pp \to \tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$, which has the maximum cross section of the electroweak productions of the supersymmetric particles with multiple leptons in final states. The lightest charginos and the second lightest neutralinos are assumed to be wino-like and have degenerate mass spectra $m_{\tilde{\chi}_1^{\pm}} = m_{\tilde{\chi}_2^0}$, and directly decay into the lightest neutralinos and the Standard Model bosons (W, Z or Higgs) with 100% branching ratio (simplified model). The lightest neutralino is assumed to be bino-like. This thesis discusses the results of the search in the channels with three leptons ($\ell = e, \mu, \tau$) and missing transverse momentum in final states, in particular the detail of the setting of the optimal selections (signal regions) and a method of estimating fake lepton contributions in order to achieve the best sensitivity with the acquired data.

The data is collected with a multipurpose detector, the ATLAS detector, which consists of the inner detector and the muon spectrometer for the particle tracking and the calorimeters for the energy measurement. The event triggers are performed at the calorimeters and the muon spectrometer. Particles are identified from the information of the reconstructed track and energy with kinematical selections.

For the scenario where charginos and neutralinos decay into W and Z, respectively (WZ channel), 20 signal regions are set in order to use the shapes of the distributions. For the scenario where charginos and neutralinos decay into W and Higgs, respectively (Wh channel), the bias of the difference of the azimuthal angles for the $h \to WW$ channel and the Higgs mass requirement for the $h \to \tau\tau$ channel contribute to obtain maximal sensitivity.

The background suppression is improved in this thesis. Estimation of the mis-identified leptons (fake leptons) of the analysis has been performed using a data-driven method called the simplified matrix method. This method uses the fake probabilities for various fake origins. The fake probabilities are calculated in each signal region. Improving binning of the fake probabilities with the transverse

momentum p_T and the pseudorapidity η has contributed to reproduce the fake backgrounds precisely. Validation of the estimation of the background modelling works satisfactorily within the uncertainties. No significant deviation from the Standard Model expectation has been observed. Exclusion limits for masses of charginos and neutralinos are set at 95% confidence level at simplified models $m_{\tilde{\chi}_1^\pm} < 360\ \mathrm{GeV}$ (WZ decay channel) and $m_{\tilde{\chi}_1^\pm} < 150\ \mathrm{GeV}$ (Wh decay channel) for the zero-mass lightest neutralino. The exclusion limit for the Wh channel has been set for the first time.

The specific analysis for the scenario where the difference of masses between the second lightest neutralino and the lightest neutralino is less than $50\ \mathrm{GeV}$ has also been carried out. The region has leptons with low transverse momenta p_T, hence it is difficult to suppress the fake contribution. In this thesis, the specific variables related to the initial state radiation jets and a method for fake estimation based on the simplified matrix method are investigated and applied to the signal regions. The exclusion limit is set to the simplified model of the compressed mass scenario as $m_{\tilde{\chi}_2^0} < 110\ \mathrm{GeV}$ for the difference of masses of $\Delta m_{\tilde{\chi}_2^0, \tilde{\chi}_1^0} = 25\ \mathrm{GeV}$.

These results are consistent with the corresponding results obtained by the CMS Collaboration. The results are interpreted for the scenario with the sleptons channel and the pMSSM. For the sleptons channel, the $700\ \mathrm{GeV}$ charginos are excluded with the assumption that the slepton mass is in the middle of the charginos and the lightest neutralinos. For the pMSSM scenario, the $200\ \mathrm{GeV}$ charginos are excluded. This analysis has largely improved the existing limits from the LEP analyses and the ATLAS $7\ \mathrm{TeV}$ analyses.

Discussions are given in terms of the dark matter limits and the deviation of the muon anomalous magnetic moment. As the thesis assumes that the lightest neutralino is the bino-like, the Higgs annihilation or the bino-wino coannihilation processes are necessary in order to reduce the relic density of the dark matter, according to the Planck Experiment. The exclusion limit is set for Higgs annihilation scenario, while the bino-wino coannihilation scenario cannot be excluded in this analysis. A part of the favourable region where the new quantum corrections of the supersymmetric particles are the source of the deviation of the muon anomalous magnetic moment has been excluded by this analysis.

The prospects for the improvement of this analysis for next LHC Run-2 are also discussed. The suppressing and estimating precisely for fake backgrounds are important for upcoming experiments.