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主　論　文　の　要　旨

論文題目　Search for Minimal Universal Extra Dimensions in the final state involving muons, jets and missing transverse energy in $\sqrt{s}$ = 8 TeV pp collisions with the ATLAS detector
(ATLAS 測定器による終状態にミューオン、ジェット、横方向損失エネルギーを含む余剰次元粒子の探索)

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論　文　内　容　の　要　旨

This thesis presents the search for Minimal Universal Extra Dimensions (mUED) in $\sqrt{s}$ = 8 TeV proton-proton collisions in the final state involving low momentum (soft) muons, jets and missing transverse energy. The dataset used corresponds to the integrated luminosity of 20.1 fb^{-1} delivered by the Large Hadron Collider (LHC) in 2012 and recorded with the ATLAS detector.

The mUED model is an extension of the Standard Model (SM) of particle physics which postulates the existence of one flat extra spatial dimension accessible to all the SM fields. Particles propagating in the compactified extra dimension form a tower of Kaluza-Klein (KK) states. Due to the symmetry called the KK-parity, the lightest KK-particle (LKP) is stable and is a plausible dark-matter candidate. The preferred mass of the dark-matter LKP lies at the TeV scale, making it accessible at the LHC. Due to typically small mass splittings between the mUED states in the phase-space region of interest, the decay products of KK-particles have relatively low momentum. Thus the characteristic signature of mUED at the LHC consists or relatively soft leptons and jets, in addition to the missing transverse energy (E_T^{miss}) caused by the LKP escaping detection.

The search for mUED is conducted in the final state containing two muons with transverse momenta between 6 GeV and 25 GeV. In order to ensure efficient prompt-lepton identification at low momenta a dedicated lepton performance study, in terms of lepton isolation optimisation, is performed as a first step. The optimised isolation results in a considerable improvement in the separation of signal leptons from the non-prompt (fake) lepton background. Next, the event selection is optimised to increase the signal-to-background ratio. Large part of the SM backgrounds is suppressed by requiring relatively large E_T^{miss}, in addition to placing an upper bound on muon momenta. Top-quark pair production (tt) is further suppressed by vetoing the presence of b−quark-initiated jets in the final state. The fake muon background is estimated in a fully data-driven way, where the probability of non-prompt muons being identified as prompt is measured in the data and used as an input to the method. The contribution of the tt background is estimated in a semi data-driven way, where the tt normalisation factor is extracted with a profile-log-likelihood fit to the data in the tt control region, and the Monte Carlo simulation is used for the extrapolation of the fit result to the signal region. Purely Monte Carlo based estimate is used for other minor backgrounds.

No excess above the SM expectation is observed in the signal region. The upper limit at 95% confidence level (CL) on the number of non-SM events of 7.7 is set using the CL_S method. This limit corresponds to an upper limit on the visible cross section of 0.39 fb. Limits are also set on the parameters of the mUED model. Values of the inverse compactification radius R^{-1}, corresponding approximately to the LKP mass, below 940 GeV are excluded at 95% CL for ΛR □ 5, where Λ is the ultra-violet cut-off of the theory. The analysis presented in this thesis places the most stringent limits on the LKP mass for ΛR □ 5 region up to date. It is the first dedicated search for mUED in the final state involving soft muons, the signature which is challenging in the high-luminosity and high-energy environment of the LHC. As various other new-physics models could exhibit similar final states, in particular compressed Supersymmetry, the significance of the work in this thesis extends beyond testing the mUED model. Subsequent reinterpretations of the model-independent limits on the visible cross section could constrain other new-physics scenarios resulting in similar signatures.