

論文 / 著書情報
Article / Book Information

題目(和文)	ATLAS実験におけるレプトンフレーバー非保存崩壊 $\tau \rightarrow 3\mu$ の探索
Title(English)	Search for lepton-flavor-violating decay $\tau \rightarrow 3\mu$ at the ATLAS experiment
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Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

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（理学） Doctor of
学生氏名： Student's Name	小林 大		指導教員（主）： Academic Advisor(main)	久世 正弘
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要旨（英文 800 語程度）

Thesis Summary (approx.800 English Words)

The Standard Model (SM), established by the experimental results, describes the nature. But it also has shortcomings about dark matter, fine tuning of the parameters, and gravity. Several physics models beyond the standard model (BSM) are proposed to solve these problems. Lepton Flavor Violation in the charged sector (cLFV) is strictly restricted in the SM framework, therefore its observation should be an evidence of BSM. In a high energy collision of protons at the Large Hadron Collider (LHC), a large number of tau leptons are produced. This is a unique merit for the rare decays of τ leptons with cLFV. In this thesis, the target of search is the signature that a τ lepton decays into three muons ($\tau \rightarrow 3\mu$). The branching ratio of this decay mode has not been measured yet, and the upper limit is set to be 2.1×10^{-8} by the Belle experiment.

In 2012, the proton-proton collision with the center-of-mass energy of 8TeV was provided at LHC. The integrated luminosity which is recorded by the ATLAS experiment was 19.2fb^{-1} for physics analyses. Most of τ leptons are produced by decays of W bosons and Heavy Flavor (HF) hadrons. In order to determine the branching ratio, it is necessary to use τ leptons from the specific sources and to measure its number. In the analysis using data taken in 2012, τ leptons from the decays of W bosons are used as the target. This W-originated signature has characteristic features in the large undetectable energy by neutrino, the highly collimated three muons, and the large distance from the interaction point to decay point. However, it is difficult to set the thresholds for each variable without signal loss. Multi-Variate-Analysis (MVA) technique was introduced in order to maximize the sensitivity. Using the combination of the cut-based and MVA selection criteria, background events from leptonic HF decays, accidental coincidence, and fake muons, are suppressed with maximizing the signal efficiency. The efficiency of the trigger and reconstruction also has to be estimated carefully because the correlation between collimated muons should be considered. This correlation was evaluated using boosted J/ψ mesons decaying into muon pairs. On the other hand, the number of $W \rightarrow \tau \nu$ is determined by the measurement of the other leptonic decay, i.e. $W \rightarrow e \nu$ and $W \rightarrow \mu \nu$. The branching ratios of these three decays are almost the same, therefore it can be estimated directly. As a result, there are no events in the signal region, around τ lepton mass of the invariant mass reconstructed by three muons. The evidence of the cLFV in τ leptons was not discovered, but the upper limit of the decay is set to be 3.76×10^{-7} by this result. Although this limit is not the most stringent for this channel, it is the first result in ATLAS and shows its possibility of cLFV search in rare decays not only in the heavy particle decaying into different flavored charged lepton pairs. Also, rooms for improvements for efficiency and increasing the number of τ leptons are shown.

In the Run2 period, which is started at 2015 with the higher center-of-mass energy of 13TeV, sensitivity is expected to improve by dedicated triggers developed for this analysis, increasing production cross-sections, and evolution of the integrated luminosity. The sensitivity of W-originated analysis is prospected to be 4.1×10^{-8} with the integrated luminosity of 100fb^{-1} . In addition, the HF-originated analysis, which was not performed in 2012 due to less efficient triggers, is also planned in Run2. The sensitivity is estimated focusing on the signal event from D_s mesons in 2016. Not only the search for the signal, and also the measurement of the number of D_s mesons using $D_s \rightarrow \phi \pi \rightarrow \mu \mu \pi$ events is performed. This study is extended to the inclusive search using all B, D hadrons by simple factoring.

The sensitivity is expected to be 5.6×10^{-7} with the integrated luminosity of 100fb^{-1} . These prospects are estimated based on the analysis procedure in 2012, therefore both the proposed sensitivities will be improved by optimization of the analysis procedures. These strategies for analysis and efficiency measurement can be used not only for such rare decay searches, but also for searches for new light particles decaying into muons. Hence, this study extends the possibility of the exploration in hadron collider experiments.

備考：論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。
Note：Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).

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