論文の内容の要旨

Search for lepton flavor violating muon decay mediated by a new light particle in the MEG experiment

(MEG 実験による軽い新粒子に媒介されたレプトンフレーバーを破るミュー粒子崩壊の探索)

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Recently, in elementary particle physics research, exploring new physics beyond the standard model has been actively conducted. However, there is no clear evidence of such a new physics to date but of some anomalies. To tackle this situation, we have searched for lepton flavor violating muon decay mediated by a new light particle. The charged lepton flavor violation is one of the powerful tools to search for new physics beyond the standard model. On the other hand, light new physics has attracted a great deal of attention. In the analysis performed in this thesis, we combined these two different directions and have searched for the $\mu^+ \to e^+X, X \to \gamma\gamma$ decay using the full datasets (2009–2013) of the MEG experiment.

The MEG experiment was designed to search for lepton flavor violating muon decay, $\mu^+ \to e^+\gamma$, not for $\mu^+ \to e^+X, X \to \gamma\gamma$. However, we made full use of the resources developed for the $\mu^+ \to e^+\gamma$ search. we have newly developed reconstruction methods and dedicated corrections for the $\mu^+ \to e^+X, X \to \gamma\gamma$ search. The search analysis has been completely renewed; we combined blind, cut-counting, and maximum likelihood analysis. The full datasets of the MEG experiment, which corresponds to 7.5×10^{14} μ^+s decay on the target, were analyzed. No significant excess was found in the mass region of 20–45 MeV, lifetime below 40 ps. Thus, we set the most stringent branching ratio upper limits in the mass region of 20–40 MeV. Especially, upper limits are pushed down to the level of $\mathcal{O}(10^{-11})$ for 20–30 MeV.

It is at most 60 times stringent result than the bound converted from the previous experiment, the Crystal Box experiment. Together with the previous analysis using the first-two-year physics data of the MEG experiment, this is the first direct search of the $\mu^+ \to e^+X, X \to \gamma\gamma$ decay in the world.