論文の内容の要旨

Search for the Lepton Flavor Violating Decay $\mu^+ \to e^+\gamma$ With A Sensitivity of 10^{-12}

(10^{-12} の感度によるレプトンフレーバーを破る崩壊$\mu^+ \to e^+\gamma$ の探索)

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The MEG experiment is a precise rare decay search designed to observe $\mu^+ \to e^+\gamma$ or lack thereof as a sensitive low energy probe of new physics. In this thesis we present an updated result using the data taken in 2010, which correspond to 1.1×10^{14} muon decays in the stopping target.

The previous preliminary result based on the 2009 data gave a higher than expected upper limit of 1.5×10^{-11} at 90% C.L. with a few possible events in the signal region[1] [2][3]. To examine this result, we analyzed the 2010 data which has twice higher statistical sensitivity than the 2009 data. In addition, we improved several aspects of calibration and analysis such as detector alignment, implementation of correlations in position observables, improved magnetic field map and improved likelihood analysis. We applied these improvements to the 2009 data and confirmed that the result remained essentially unchanged.

We adopted a ”blind analysis” and a maximum likelihood fit. After unblinding the signal region, the number of of $\mu^+ \to e^+\gamma$ decay events in the data sample is extracted by a maximum likelihood fit. A 90% confidence interval is then constructed using the Feldman-Cousins technique. We evaluated an expected sensitivity of the 2010 data to be 2.2×10^{-12} by toy Monte Carlo experiment, which was also confirmed by analysis of the side band data. All the analysis is done by hiding the signal region until probability density functions for a likelihood fit are settled upon.

The obtained result is consistent with a null hypothesis and we set an upper limit on the branching ratio

$$B(\mu^+ \to e^+\gamma) < 1.7\times10^{-12} \text{ at 90\% C.L.}$$

for the 2010 data and

$$B(\mu^+ \to e^+\gamma) < 2.4\times10^{-12} \text{ at 90\% C.L.}$$

for the combined data of 2009 and 2010.

This result exceeds the previous world's best limit of 1.2×10^{-11} set by the MEGA experiment[4].

References:

[1] Ryu Sawada. Analysis of the MEG experiment to search for μ+ → e+γ decays. In PoS (ICHEP 2010), page 263, Paris, 2010.

[2]Alessandro Massimo Baldini. Rare lepton and k-meson decays. In PoS (ICHEP 2010), page 528, Paris, 2010.

[3]Y. Nishimura. A Search for the Decay μ+ → e+γ Using a High-Resolution Liquid Xenon Gamma-Ray Detector. PhD thesis, University of Tokyo, 2010.

[4]M.L. Books and others. New limit for the family-number non-conserving decay μ+ → e+γ. Phys. Rev. Lett., 83:1521, 1999.