

博士論文公聴会の公示（物理学専攻）

学位申請者： TingSam Wong

論文題目： Search for Negative Muon to Positron conversion in the COMET Phase-I experiment

（COMET Phase-I 実験における負電荷ミュオン陽電子転換過程探索の研究）

日時： 2020年2月7日（金） 14:40 - 16:10

場所： 理学研究科 H 棟 7 階セミナー室（H701 号室）

主査：久野良孝

副査：青木正治、川畑貴裕、南條創、能町正治

論文要旨：

The existence of violation of the fundamental conservation laws, such as charged lepton flavor violation (CLFV) and lepton number Violation (LNV) would be two fundamental issues that would lead to discovery of new physics phenomena beyond the Standard Model (SM) of particle physics. Discovery of CLFV and LNV will also enhance our understanding of the lepton origin in the SM. The muon-to-positron conversion (μ^-e^+ conversion) in a muonic atom is considered as one of the best candidates to study CLFV and LNV. Currently, the COherent Muon to Electron Transition (COMET) Phase-I experiment at J-PARC is essentially one of the frontier experiments that can provide an opportunity to measure not only μ^-e^- conversion in ^{27}Al but also μ^-e^+ conversion. From the simulation studies with the setup of the COMET Phase-I experiment, the $^{27}\text{Al}(\mu^-, e^+)^{27}\text{Na}$ is shown to have a large background contamination. Hence, a list of the other candidates of muon stopping target materials such as ^{32}S , ^{40}Ca , ^{48}Ti , ^{50}Cr , ^{54}Fe , ^{58}Ni , ^{64}Zn and ^{70}Ge are proposed.

Considering only the ground state transition of the conversion process, we conclude that conversion process involving ^{32}S and ^{40}Ca are the best candidates because of their high sensitivity and low background properties. We report the upper limit and background events to be $\text{Br}(\mu^- + ^{40}\text{Ca} \rightarrow e^+ + ^{40}\text{Ar}) < 4.1 \times 10^{-14}$ (90% C.L.) with 0.09 background and $\text{Br}(\mu^- + ^{32}\text{S} \rightarrow e^+ + ^{32}\text{Si}) < 3.0 \times 10^{-14}$ (90% C.L.) with 0.3 background in 150 days of physics measurement. This result would improve on the previous limit of SINDRUM-II experiment¹ by two orders of magnitude.

¹ J. Kaulard et al. “Improved limit on the branching ratio of $\mu^- \rightarrow e^+$ conversion on titanium”. In: Phys. Lett. B422 (1998), pp. 334–338. DOI: [10.1016/S0370-2693\(97\)01423-8](https://doi.org/10.1016/S0370-2693(97)01423-8).