Search for the coherent neutrinoless transition of a muon to an electron in a muonic atom with the COMET experiment at J-Parc

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Several experiments are looking for Beyond the Standard Model signals through charged lepton flavour violation (cLFV) searches. Being forbidden in the Standard Model (SM), and strongly suppressed in minimal SM extensions capable of accounting for neutrino oscillation data, cLFV is a particularly powerful probe for New Physics.

The muon sector offers numerous cLFV channels (rare decays and transitions), and the advent of very intense muon beams render it one of the best laboratories to look for cLFV. The neutrinoless muon-electron conversion of a muonic atom is a particularly interesting observable: current bounds on the conversion rate are already extremely stringent and are expected to be dramatically improved by upcoming experiments. Among them, The COherent Muon to Electron Transition (COMET) experiment at the Japan Proton Accelerator Research Complex(J-PARC) in Tokai, will look for neutrinoless muon-electron conversion.

The collisions of the proton beam with a graphite target produce pions which then decay into muons; the rate of low energy muons is artificially increased using a pion capture solenoid. The muons are subsequently charge and momentum selected by propagating them through a transport solenoid, before being stopped in an aluminum target surrounded by a cylindrical drift chamber (CyDet), placed in a 1T magnetic field.

The physics of COMET Phase-I relies essentially on CyDet that will identify the 105 MeV electrons created by the neutrinoless muon-electron conversion. However, improving the stringent limits already existent on this process requires a very intense muon beam and an even tighter control of the backgrounds, both generated by the proton beam interaction with the graphite target and by the atmospheric muon flux.

The LPC group, who joined the COMET collaboration in September 2018, works on what may well be the main background affecting the measurement: the one induced by atmospheric muons. The group is in charge of providing both a robust estimate of this background and an extension of the present Cosmic Ray Veto to control it.

The M2 candidate will work on the reconstruction of the electrons and electron-like events induced by atmospheric muons in order to (1) define the best strategies for rejecting them and (2) define the required performance of the Cosmic Ray Veto in terms of position resolution and efficiency for ensuring a background contamination less than 0.01 in one year of data taking.

A PhD on cLFV search with COMET will be proposed in 2019.