MUONIUM HYPERFINE SPLITTING MEASUREMENT IN J-PARC

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Muonium is a hydrogen-like atom composed of a positive muon and an electron. Purely leptonic feature of this exotic atom allows rigorous test of bound-state QED (quantum electrodynamics) as well as precise determination of the magnetic moment of muon and hence its mass. The ratio of magnetic moments between muon and proton is an indispensable input parameter in deducing the anomalous magnetic moment ($g - 2$), an important physical quantity for the test of the Standard Model and beyond.

MuSEUM Collaboration aims at a precision microwave spectroscopy of the ground state of the muonium atom at J-PARC in Japan. High-intensity pulsed muon beams will be stopped in a krypton gas target in a microwave cavity to form muonium atoms. Resonant spin-flip transitions between hyperfine sublevels of the atom will then be detected by observation of positrons emitted favorably in the direction of the muon spin at the time of the muon decay. The center frequency of the resonance will be determined at an ultimate relative precision of the order of 10 ppb (10^{-8}). We are planning our measurement under two complementary conditions: one at a high magnetic field of 1.7 T, and another at zero field.

The major source of the uncertainty was statistics in the past experiments, which can be reduced with the high-intensity beam, while systematic uncertainties will be minimized by various improvements in our experimental setup and careful considerations with computer simulations. Extensive studies have been done for uncertainties arising from microwave power fluctuations, magnetic field in homogeneity, muon stopping distribution and gas-density shift of resonance frequencies.