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Present status of muonium hyperfine splitting in J-PARC

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Muonium is the bound state of a positive muon and an electron. Muonium Spectroscopy Experiment Using Microwave (MuSEUM) is a new precise measurement of muonium hyperfine structure (MuHFS) at Japan Proton Accelerator Research Complex (J-PARC).

There are two major motivations for this new measurement.

1. Test of the bound-state Quantum Electrodynamics (QED). Muonium is a purely leptonic system and the theoretical calculation of its hyperfine structure is more precise than that of hydrogen. By comparing the experimental result and the theoretical calculation, one can test the bound-state QED precisely.

2. Contribution to the search for BSM physics via muon g-2. Muon anomalous magnetic moment, a[^]V, is known for the 3 sigma tension between the experimental value at BNL and the theoretical value from the standard model. Two new experimental projects to measure muon g-2 more precisely (100 ppb) are ongoing at J-PARC and Fermilab using a muon storage ring. To extract a, these storage ring experiments

need an input parameter, which can be precisely determined by the MUHFS spectroscopy. MuSEUM determines the parameter with a precision of 10 ppb, a factor of twelve improvement from the precursor experiment at Los Alamos Meson Physics Facility (LAMPF), without assuming the bound state QED is correct. The lack of the statistics was the most dominant source of the uncertainty in the precursor experiments at LAMPF. New intense pulsed muon beam at J-PARC has opened the opportunity to improve the experimental result. A new muon beam line at J-PARC, HLine, with ten times more muon intensity is under construction and will be ready for use in a few years. In future, more intense pulsed muon beam source can accelerate the improvement of the precision. In this presentation, we report the recent results of the measurement at very weak field and the study of the systematic uncertainty. We also mention the future prospect, including preparation for high field measurement.

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