Laser spectroscopy of 1S-2S transition in muonium at J-PARC

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Muonium is a bound state consisting of a positive muon and an electron. This purely leptonic tow-body system can realize precise comparison of theoretical calculation based on the Standard Model of particle physics with experimental measurement without ambiguity from the complicatedness of the nucleus. Thus, accurate spectroscopy of muonium is motivated to study new physics beyond the Standard Model. [1]

We are conducting laser spectroscopy of the 1S-2S transition in muonium. Accurate energy of this transition can also reduce the muon mass, which is now determined at a 120 ppb level [2], in the highest accuracy, a 10 ppb level if the energy is measured at a 100 kHz level. The improvement of the muon mass accuracy enables more strong verification of the Standard Model by combining it with measurements of muon magnetic anomaly [3] and hyperfine splitting [4], for example.

The experiment is ongoing at J-PARC (Japan proton accelerator research complex). We have built a muon beam line and a laser system since 2020. After the muon beam line commissioning on January 2022, we have started the laser spectroscopy. The 1S-2S transition has been observed as shown in Figure 1, and various resonance curves have been measured in 2022. We have obtained ~50 times higher counting rate of 1S→2S excitation events from the previous experiment in 2000 [5]. We will the report on recent progress and prospect of the experiment.

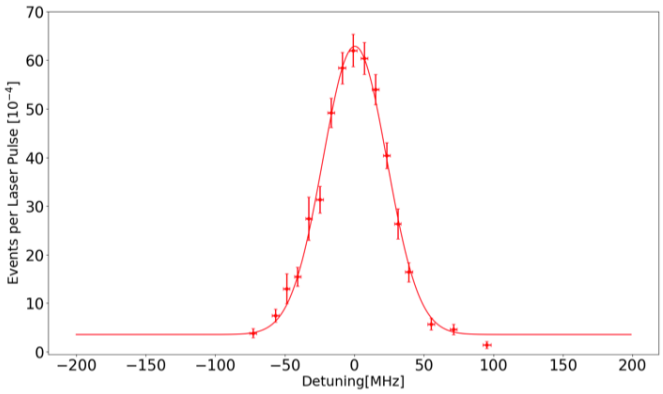

Figure 1 Observed resonance curve of 1s-2s excitation.

References:

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