Contribution ID: **71** Type: **Oral presentation**

New results of positronium 1S-2S transition and Muonium Fine structure

Monday 8 September 2025 17:20 (20 minutes)

Positronium and muonium, as purely leptonic atoms without internal structure, provide ideal systems for high-precision tests of quantum electrodynamics (QED) [1] and measurements of fundamental constants. Here, we present the recent results we obtained at ETH on the $1^3S_1 \rightarrow 2^3S_1$ transition in positronium, measured via two-photon optical spectroscopy with a continuous-wave laser. The preliminary analysis estimates that the total uncertainty of this measurement at 5 ppb, comparable to the most precise measurement to date (2.6 ppb) [2]. We also outline the ongoing efforts by the MuMASS collaboration to improve the precision on the state-of-the-art measurements of the 1S-2S in muonium via CW laser [3] spectroscopy. The future prospects of positronium and muonium 1S-2S spectroscopy employing a novel Ramsey-Doppler scheme [4] will also be presented.

In addition, we present a recent measurement at PSI by MuMASS of the fine structure of muonium, which follows from the experiment that determined the muonium Lamb shift [5, 6]. A preliminary analysis of the experimental data indicates that the observed transition frequency is consistent with theoretical predictions, with a total uncertainty of around about 7 parts in 10,000, making it the most precise determination to date. The upcoming High-Intensity Muon Beam (HiMB) at the Paul Scherrer Institute (PSI) in Switzerland will allow to increase the statistics on such a measurement to enable precise tests of bound state QED, while also providing tests of new physics [7].

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Session Classification: Session