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Precision spectroscopy of the 2S-4P transition in atomic hydrogen LOTHAR MAISENBACHER, AXEL BEYER, ARTHUR MATVEEV, ALEXEY GRININ, Max Planck Institute of Quantum Optics (MPQ), RANDOLF POHL, MPQ and Johannes Gutenberg University, Mainz, KSENIA KHABAROVA, NIKOLAI KOLACHEVSKY, Lebedev Physical Institute, Moscow, THEODOR W. HÄNSCH, MPQ and Ludwig Maximilians University, Munich, THOMAS UDEM, MPQ — Precision measurements of atomic hydrogen have long been successfully used to extract fundamental constants and to test bound-state QED. However, both these applications are limited by measurements of hydrogen lines other than the very precisely known 1S-2S transition. Moreover, the proton r.m.s. charge radius r_p extracted from electronic hydrogen measurements currently disagrees by $4\,\sigma$ with the much more precise value extracted from muonic hydrogen spectroscopy. We have measured the 2S-4P transition in atomic hydrogen using a cryogenic beam of hydrogen atoms optically excited to the initial 2S state[1]. The first order Doppler shift of the one-photon 2S-4P transition is suppressed by actively stabilized counter-propagating laser beams and time-of-flight resolved detection[2]. Quantum interference between excitation paths can lead to significant line distortions in our system. We use an experimentally verified, simple line shape model to take these distortions into account. With this, we can extract a new value for r_p and the Rydberg constant R_∞ with comparable accuracy as the combined previous H world data.

[1]A. Beyer et al., Physica Scripta 165 014030 (2015)
[2]A. Beyer et al., Optics Express 24, 17470 (2016)

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