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Precision spectroscopy of the 2S-4P transition in atomic hydrogen LOTHAR MAISENBACHER, AXEL BEYER, Max Planck Institute of Quantum Optics Garching, KSENIA KHABAROVA, Lebedev Physical Institute Moscow, ARTHUR MATVEEV, RANDOLF POHL, THOMAS UDEM, Max Planck Institute of Quantum Optics Garching, THEODOR W. HÄNSCH, Max Planck Institute of Quantum Optics Garching, Ludwig Maximilians University Munich, NIKOLAI KOLACHEVSKY, Max Planck Institute of Quantum Optics Garching, Lebedev Physical Institute Moscow — A precision measurement of the 2S-4P transition in atomic hydrogen, when combined with the precisely known 1S-2S transition frequency[1], can be used to determine the value of the r.m.s. proton charge radius r_p. We report on our progress towards an absolute frequency measurement, using a cryogenic beam of atoms optically excited to the metastable 2S state[2]. This strongly suppresses the first order Doppler shift, which is further reduced using actively stabilized counter-propagating laser beams for the 2S-4P (one-photon) excitation. We experimentally verify this suppression using time-of-flight resolved detection. We present a theoretical and experimental study of interference effects due to spontaneous emission[3] and the corresponding line center shifts, using a segmented detector to spatially resolved the emission pattern. An experimental scheme to suppress this systematic shift and extract the unperturbed transition frequency is shown and future measurements of transitions to higher nL states are discussed.

[1]C. G. Parthey et al., PRL 107, 203001 (2011)
[2]A. Beyer et al., Ann. Phys. 525, 671 (2013)
[3]M. Horbatsch and E. A. Hessels, PRA 82, 052519 (2010)

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