# Ultrahigh-Resolution Spectroscopy of the Hydrogen Atom

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Precise determination of transition frequencies in atomic hydrogen provides one of the most critical confrontation of experimental data with the theory of quantum electrodynamics (QED). The sharpest transition in atomic hydrogen occurs between the metastable 2S state and the 1S ground state. It's transition frequency has now been measured with almost 15 digits uncertainty using an optical frequency comb and a cesium atomic clock as a reference [1]. In combinations with other measured transition frequencies one can determine the value of the Rydberg constant and the proton charge radius, that enter the QED description as parameters. The hydrogen data has been self-consistent in this analysis.

A recent measurement of the Lamb shift in muonic hydrogen has allowed determining the proton charge radius with a largely reduced uncertainty [2]. However, this value contradicts results obtained with ordinary hydrogen. We hope that we can shed light ob this discrepancy by providing additional experimental input with increased accuracy.

The 1S-2S two-photon transition in singly ionized helium is a highly interesting candidate for precision tests of bound-state QED. With the recent advent of extreme ultraviolet frequency combs, highly coherent quasi-continuous-wave light sources at 61 nm have become available, and precision spectroscopy of this transition now comes into reach [3].

## References

[1] C.Parthey *et al.* Phys. Rev. Lett.  79, 052505 (2009).
[2] R.Pohl *et al.* Nature. 466, 213 (2010).
[3] M.Herrmann *et al.* Phys. Rev. A 79, 052505 (2009).