MAX PLANCK INSTITUTE
OF QUANTUM OPTICS

LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

Master thesis: differentially pumped 243nm cavity for laser spectroscopy of atomic hydrogen and deuterium

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Precision laser spectroscopy of atomic hydrogen and deuterium has long been used to determine physical constants and to test fundamental theories, owing to the simple structure of atoms allowing comparison with precise calculations. We are continuously improving constraints on these tests and shine light on possible discrepancies, such as the proton radius puzzle [1]. At the moment, we are working towards measuring the 2S-6P transition in deuterium which allows for determination of the deuteron radius and further tests of quantum electrodynamics. To reach the required fractional uncertainty of a few parts in 10^{12} of the transition frequency, a sophisticated control over systematic effects such as quantum interference is required [2].

Though similar to a hydrogen measurement, the spectroscopy of deuterium requires careful control of the laser polarization and a detailed understanding of the atomic line shape. We are **looking for a master student for the deuterium spectroscopy experiment** who is interested in working with a typical atomic physics toolkit, including **optics, lasers, fibers and electronics**. More specifically, the master student would participate in upgrading our apparatus to a differentially pumped 243nm cavity which is used to generate metastable atoms in the 2S excited state. This setup would prevent degradation of the UV mirrors [3] and thus greatly increase the up-time of the experiment. The project includes mostly hands-on experimental work with the vacuum system as well as the optical setup of the enhancement cavity.

If you are interested in joining our team and want to learn more about the project, do not hesitate to contact Vitaly Wirthl (vitaly.wirthl@mpq.mpg.de). Please send your application along with your CV to Prof. Thomas Udem (thu@mpq.mpg.de) with CC to Vitaly.

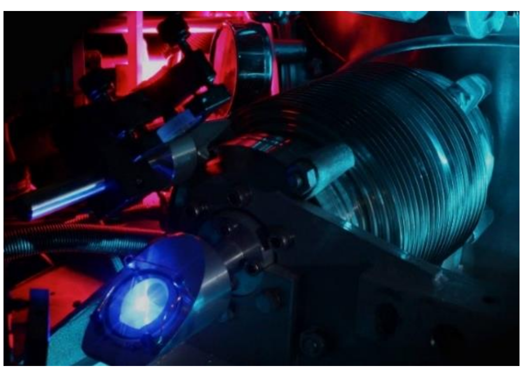

Photo showing the vacuum chamber used to measure the 2S-4P transition frequency in atomic hydrogen. The purple glow in the back stems from the microwave discharge that dissociates hydrogen molecules into hydrogen atoms. The blue light in the front is fluorescence of the vacuum viewport from the ultraviolet laser that excites the atoms to the 2S state. The turquoise blue glow is stray light from the laser system used to measure the frequency of the 2S-4P transition. (Credit: Axel Beyer / MPQ)

Key references

[1] Beyer, A. *et al.* The Rydberg constant and proton size from atomic hydrogen. *Science* **358**, 79–85 (2017).

[2] Udem, T. *et al.* Quantum Interference Line Shifts of Broad Dipole-Allowed Transitions. *Annalen der Physik* **531**, 1900044 (2019).

[3] Cooper, S. F.. *et al.* Cavity-enhanced deep ultraviolet laser for two-photon cooling of atomic hydrogen. *Opt. Letters* **43**(6), 1375-1378 (2018).