Contribution ID: **52** Type: **Talk**

Precision measurements of nk – 2s transition frequencies in the hydrogen atom

Monday 3 July 2023 09:45 (25 minutes)

Precision spectroscopic measurements in the hydrogen atom have a long tradition and extensive studies of transitions between states with principal quantum number $n \leq 12$ have been carried out [1-6]. These measurements can be used to determine values of the Rydberg constant and the proton charge radius [7]. We present a new experimental approach to perform measurements of transition frequencies between the metastable 2s $^2\mathrm{S}_{1/2}(F = 0, 1)$ states of H and highly excited $n\,k$ Rydberg Stark states with principal quantum number $n \geq 20$.
\\We generate the hydrogen atoms by dissociating H_2 in a dielectric barrier discharge located at the orifice of a pulsed cryogenic valve [8]. The hydrogen atoms are entrained in the supersonic expansion of H_2. The atoms are photoexcited to a specific hyperfine level of the metastable 2s $^2\mathrm{S}_{1/2}$ state by a home-built frequency-tripled Fourier-transform-limited pulsed titanium-sapphire laser (pulse length 40 ns) and enter a magnetically shielded region in which transitions to $n\,k$ Rydberg Stark states are induced by a narrow-band frequency-doubled continuous-wave titanium-sapphire laser, which is phase locked to an optically stabilized frequency comb and referenced over a fiber network to a SI traceable primary frequency standard [9]. The highly excited Rydberg states are detected by pulsed-field ionization. We present our measurement procedure and first results on the ($n = 20\,k = 0$) - 2s transition frequency.
This work was supported by the Swiss National Science Foundation through the Sinergia-Program (Grant No. CRSII5-183579) and Grant No. 200020B-200478.
[1] J. C. Garreau *et al.*, J. Phys. France **51**, 2293 (1990).
[2] C. G. Parthey *et al.*, Phys. Rev. Lett. **107**, 203001 (2011).
[3] A. Beyer *et al.*, Science **358**, 79 (2017).
[4] H. Fleurbaey *et al.*, Phys. Rev. Lett. **120**, 183001 (2018).
[5] N. Bezginov *et al.*, Science **365**, 1007 (2019).
[6] A. Grinin *et al.*, Science **370**, 1061 (2020).
[7] E. Tiesinga *et al.*, J. Phys. Chem. Ref. Data **50**, 033105 (2021).
[8] S. Scheidegger *et al.*, J. Phys. B: At. Mol. Opt. Phys.**55**, 155002 (2022).
[9] D. Husmann *et al.*, Optics Express **29**,24592 (2021).

Author: SCHEIDEGGER, Simon

Co-authors: MERKT, Frédéric (ETH Zürich); SCHMUTZ, Hansjürg (ETH Zürich); AGNER, Josef A. (ETH Zürich)

Presenter: SCHEIDEGGER, Simon

Session Classification: Atoms and Exotic Atoms I