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The Hydrogen 1S-3S Direct Frequency Comb Spectroscopy Experiment - Overview and Update of the Detection Scheme

Wednesday 12 June 2024 18:00 (2 hours)

Precision spectroscopy of atomic hydrogen is a powerful tool to test QED theory as energy transitions can be measured, calculated and subsequently compared on a high level of precision. As free parameters in the theory, the Rydberg constant R_∞ and the proton charge radius r_p remain to be determined by spectroscopy [3], since other parameters entering the calculation, such as the fine structure constant α or the electron-proton mass ratio m_e/m_p, are given very precisely by other experiments, e.g. atom interferometry or Penning trap experiments respectively.
Thus, two transition measurements in hydrogen are required to fix R_∞ and r_p and more to check for consistency. Adding a contribution to that quest, the 1S-3S experiment at MPQ in Garching delivered its first result in 2020 with a fractional uncertainty of 10^{-13} [2]. Since the 1S-3S transition was also measured by colleagues at the Laboratoire Kastler Brossel in Paris [1], with a value currently different to the MPQ measurement by 2.1 standard deviations, it is an experiment of particular importance as it provides the only transition measurement that has been conducted redundantly by two groups with independent systematics. Strongly hinting to unknown experimental issues, this discrepancy motivates the further improvement of the experimental setup towards a lower uncertainty measurement. In this poster an overview of the current setup of the spectrometer is given, with a focus on the characteristics of the detector that is used for fluorescence detection from the excited atoms. It also presents the current development stage of a new detector together with an outlook of improvements expected from the planned modifications.

References

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