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Ramsey-Comb Spectroscopy of the Q0 and Q1 Transitions in Molecular Hydrogen and Deuterium

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As the simplest neutral molecule, molecular hydrogen (H2) is a good testing ground for molecular quantum theory. Its dissociation energy D0 has become a benchmark value to test ab initio quantum molecular calculations. An experimental value for D0 can be obtained by relating the ionization energy of H2, to the ionization energy of atomic hydrogen and the dissociation energy of the H2 ion. By combining our measurements of the X to EF Q0 and Q1 transitions with the determination of the energy difference between the EF state and the continuum carried out at the ETH Zurich [1], we can provide an experimental value for the ionization energy of H2, and therefore of D0. In order to measure the Q0 transition in H2, we perform 2-photon Ramsey-comb Spectroscopy (RCS) [2] in the VUV at 202 nm. RCS uses two amplified and up-converted pulses out of the infinite pulse train of a frequency comb (FC) laser to perform a Ramsey-like excitation. Recent improvements to the experimental setup allowed to determine the X to EF transition frequency in H2 and D2 with 30 and 19 kHz accuracy, respectively [4]. We will report on these measurements and discuss their implications regarding an improved determination of the dissociation energy of H2 and D2, and a comparison with theory.

[1] Hölsch et al., PRL 122, 103002 (2019)
[2] Morgenweg et al, Nat. Phys. 10, 30–33 (2014)
[3] Altmann et al., PRL 120, 043204 (2018)
[4] Roth et al., Manuscript submitted (2023)

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