Ramsey-Comb Spectroscopy of the $EF^1\sum_g^+ - X^1\sum_g^+(0,0)$ Q_0 and Q_1 Transitions in Molecular Hydrogen and Deuterium

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As the simplest neutral molecule, molecular hydrogen (H_2) is a good testing ground for molecular quantum theory. Its dissociation energy D_0 has become a benchmark value to test *ab initio* quantum molecular calculations. An experimental value for D_0 can be obtained by relating the ionization energy of H_2, to the ionization energy of atomic hydrogen and the dissociation energy of the H_2 ion. By combining our measurements of the X to EF Q_0 and Q_1 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 H_2, and therefore of D_0. In order to measure the Q_0 transition in H_2, 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 laser to perform a Ramsey-like excitation. Recent improvements to the experimental setup enabled the determination of the X to EF transition frequency in H_2 and D_2 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 H_2 and D_2, 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)