PRECISION RAMSEY-COMB SPECTROSCOPY OF MOLECULAR HYDROGEN IN THE DEEP-UV

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High-precision spectroscopy experiments with simple atomic and molecular systems provide important benchmarks for tests of bound-state Quantum Electrodynamics (QED). In recent years there has been significant progress in both experiment [1,2] and theory [3] for QED tests in H_2. Even investigations of the proton radius puzzle [4] might become feasible in this molecule if the dissociation energy can be determined at a level of 10 kHz [3]. For this latter target, we developed an excitation method, Ramsey-comb spectroscopy, that enables kHz-level precision spectroscopy in the deep-UV. The method is based on excitation with amplified and upconverted frequency comb laser pulses [5]. It has allowed us to measure the $EF^1\Sigma_g^+ - X^1\Sigma_g^+(0,0)$ Q1 two-photon transition at 202 nm with an accuracy of 73 kHz [6]. This result is two orders of magnitude better than obtained with previous experiments, and combined with future improved measurements of the EF ionization energy, this could lead to a dissociation energy with an uncertainty below 100 kHz. New measurements from V=1 and N=0 are now in preparation. Moreover, a new setup has been constructed to extend Ramsey-comb spectroscopy to the vacuum- and extreme-ultraviolet spectral region through high-harmonic generation, and an experiment is in preparation to demonstrate this.

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