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High Precision Spectroscopy of the Hydrogen Molecule and its Ion

Monday 10 June 2024 18:00 (2 hours)

This project aims to perform spectroscopy of H_2 above the n=2 and n=3 dissociation limits to observe its photofragments utilizing velocity map imaging (VMI) and study the competition between predissociation and autoionization by measuring the energy and angular distribution of the Hˆ+ and H_2ˆ+ ions [1]. To this end, the molecule is first excited via a one-photon transition to the B state using a tunable XUV laser, and simultaneously a second photon is used to induce a transition above one of these dissociation limits, which causes the molecule to fragment.

Using a suitable intermediate state and a third photon, molecular Rydberg states can be excited with the ion being in various excited rovibrational levels. Employing pulsed field ionization, this establishes a new approach to selectively generate molecular ions in a single quantum state [2]. This is especially important for homonuclear molecules where the vanishing dipole moment prohibits the use of unselective ion production via electron impact. Precision measurements based on weakly bounds states of the molecular hydrogen ion exhibit high sensitivity to peculiar effects predicted by quantum electrodynamics theory and even to possible manifestations of physics beyond the Standard Model [3].

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