

Precision Measurements with Simple Molecular Hydrogen Ions at ALPHATRAP

Molecular hydrogen ions offer a unique opportunity for testing fundamental physics at high precision. As simple three-body systems, the energy levels and properties of H_2^+ , and its isotopologue HD^+ , are exactly calculable and precision spectroscopy enables measurement of fundamental constants such as the proton-to-electron mass ratio [1], including possible temporal or spatial variation [2]. In contrast to atomic hydrogen, molecular hydrogen ions have many narrow, laser-accessible transitions and can be trapped and cooled ion traps. This offers not only exciting prospects for metrology [3], but presents a viable method for creating and performing precision measurements on the antimatter counterpart [4]. We have recently demonstrated long-term trapping and quantum control a single HD^+ molecule in the rovibrational ground state at the ALPHATRAP Penning-trap apparatus [5] culminating in a measurement of the ground state hyperfine structure. This measurement allows us to extract the shielded g -factors of the proton, deuteron, and electron along with the E_4 and E_5 coefficients of the hyperfine Hamiltonian and demonstrates molecular state detection via the continuous Stern-Gerlach effect which we will use in upcoming measurements of rovibrational transitions in HD^+ and H_2^+ .

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