High Precision Measurements of Single Ions in the ALPHATRAP Penning Trap Setup

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The ALPHATRAP experiment [1] is a double Penning trap setup at the Max Planck Institute for Nuclear Physics in Heidelberg, Germany. The cryogenic trap setup allows for high precision spectroscopic measurements on single ions while utilizing the continuous Stern-Gerlach effect for state detection [2]. It is connected to a room temperature beamline with access to several different ion sources and thus a wide range of charge states are available for measurements. A cryogenic valve results in a residual pressure of below 10^{-16} mbar in the trap section leading to trapping times of several months.

In this contribution, I will give an overview of our setup and recent measurement campaigns. With our recent determination of the g factor of the bound electron of hydrogen-like tin, we have probed QED in the extreme electric field of the nucleus of 10^{17} V/m. The direct electron g-factor difference of 2 coupled neon ions ($^{20}Ne^{9+}$ and $^{20}Ne^{9+}$) measured to 0.56 ppt has, for the first time, resolved the nuclear QED recoil effect [3]. I will focus on the spectroscopy of single molecular hydrogen ions, in particular the hyperfine spectroscopy of HD^{+} probing spin-spin interaction theory and the currents steps towards rovibrational laser spectroscopy en route to high-precision measurements on single H_2^+ ions for future matter-antimattter comparisons [4].

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