High-precision hyperfine structure measurements on hydrogen-like ^{3}He and ^{9}Be

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Spectroscopy of the ground-state hyperfine structure of atoms and ions gives access to the values of the magnetic moments of the bound electron and nucleus and the interaction of the moments - the zero-field hyperfine splitting ΔE_{HFS}.

In our Penning trap setup, such a measurement has recently been carried out on $^{3}\mathrm{He}^{1+}$ to determine the magnetic moment and Zemach radius of its nucleus [1]. To use the magnetic moment for high accuracy magnetic field measurements with ^{3}He-NMR-probes [2] it has to be corrected for by a diamagnetic shielding due to the orbiting electrons. We measure the hyperfine structure of $^{9}\mathrm{Be}^{3+}$ (hydrogen-like) and by comparing it to measurements on $^{9}\mathrm{Be}^{1+}$(lithium-like) we can test the theory of the diamagnetic shielding factor [3, 4]. Additionally, through ΔE_{HFS}, this enables a comparison of the Zemach radius of ^{9}Be extracted from the hydrogen- and lithium-like system [5].

We have measured the magnetic moment of the nucleus with a relative precision of 10^{-9}, making a test of the diamagnetic shielding on the same level possible. The zero-field splitting ΔE_{HFS} extracted from the measurement to a precision of better than one part in 10^{-11} can be used to extract the Zemach radius and compare it the value of the lithium-like system. Recent improvements to our setup further allowed us to determine the bound electron magnetic moment of $^{9}\mathrm{Be}^{3+}$ to a few parts in 10^{-11}, giving an additional high-precision test of QED. The status of the project and future prospects will be presented.

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