The g-factors of lithiumlike $^{40,48}Ca^{17+}$ and their isotopic effect

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High-precision measurements of the gyromagnetic factor (g-factor) of an electron bound to a nucleus - a hydrogenlike ion - provide the opportunity to determine fundamental constants [1] and to test the theory of quantum electrodynamics of bound systems (BS-QED). The most stringent test of BS-QED in a strong electric field ($\approx 2 \cdot 10^{-15}$ V/m) has been performed by measuring the g-factor of hydrogenlike silicon $^{28}Si^{13+}$ with a relative uncertainty of $7 \cdot 10^{-11}$ [2]. The comparison of the measured g-factor of lithiumlike silicon, $^{28}Si^{11+}$, with its theoretical prediction enabled the most stringent test of electron-electron interaction [3].

To test BS-QED under even stronger conditions we are currently measuring bound electron g-factors with heavier nuclei. The comparison of the g-factors of lithiumlike $^{40}Ca^{17+}$ and lithiumlike $^{48}Ca^{17+}$ will provide the first direct measurement of the isotopic effect. The dominant contribution to the isotopic effect is the recoil correction [4].

To produce the different isotopes in a closed setup we use a miniature electron-beam-ion-source with an enriched calcium-target. After the creation-process the single ion is trapped for several months in a triple Penning trap apparatus. The g-factor is determined by measuring the ratio between the spin-precession frequency of the bound electron to the cyclotron frequency of the ion. The spin-state is determined by applying the continuous Stern-Gerlach effect. The cyclotron frequency is measured with a novel phase-sensitive detection technique, PnA (Pulse and Amplify) [5], working at ultra-low temperatures.

The experimental setup, the measurement principle, detection methods and the status of the g-factor measurements of different calcium isotopes will be presented.

References

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