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Probing the nuclear magnetisation distribution with the Bohr-Weisskopf effect using collinear laser spectroscopy

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Exploring ground-state nuclear properties is a powerful tool to investigate our understanding of nuclear structure. Laser spectroscopy gives access to nuclear ground-state properties, such as the nuclear spin, electromagnetic moments and changes in the mean-squared charge radius of short-lived ($\geq$10 ms) nuclei by measuring the hyperfine A-and B-parameters and isotope shift [1]. Conventionally, the nuclear magnetic dipole moment is extracted from the hyperfine A-parameter, assuming the magnetic field generated by the electron cloud is uniform over the nuclear volume. While generally true, this assumption breaks down for atomic states where its wavefunction significantly overlaps with the nuclear wavefunction, e.g. in $S_{1/2}$ atomic states. In these cases, the Bohr-Weisskopf (BW) contribution to the hyperfine A-parameter becomes significant, accessible to the precision of collinear laser spectroscopy and atomic theory calculations [2].

The BW effect arises from the non-uniformity of the nuclear magnetisation distribution and its interaction with the electrons; therefore, measuring the hyperfine structure in a BW-sensitive atomic state gives insight into the nuclear magnetisation distribution for short-lived ($\geq$10 ms) nuclei, so far only extracted for stable or long-lived nuclei [3,4].

I will present the significance of the BW effect on the extracted nuclear magnetic dipole moments from measurements on radioactive silver at CRIS in ISOLDE. Additionally, I will show how the absolute BW contribution can be extracted from collinear laser spectroscopy and atomic theory and the results obtained for silver. Lastly, I will present an outlook on comparing the BW effect to DFT calculations to gain insight into the nuclear magnetisation distribution.

References

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