Prof. Dr. Peter van Loock
Institut für Physik
loock@uni-mainz.de

Dr. Lars von der Wense
Institut für Physik
lars.vonderwense@uni-mainz.de

JOHANNES GUTENBERG UNIVERSITÄT MAINZ

Seminar über Quanten-, Atom- und Neutronenphysik (QUANTUM)

Jan. 12, 2023 at 2 p.m. c.t.
IPH Lorentzraum 05-127

Dr. Andreas Mooser
MPI für Kernphysik, Heidelberg

Magnetic strength of ^{3}He

The hyperfine structure of hydrogen like ions are a unique probe to access nuclear magnetic moments and nuclear structure. Thus, while eliminating the ignorance of essential links in metrology due to insufficiently known magnetic moment, at the same time these ions provide complementary insight into the inner nucleus. The very recently started ^{3}He experiment exploits these characteristics to provide a new standard for absolute precision magnetometry and determine the nuclear charge and current distribution of ^{3}He.

To this end, a novel four Penning trap experiment was designed and built. Using novel techniques, this system enables non demolition measurements of the nuclear quantum state and allows sympathetic laser cooling of single, spatially separated ions to sub-thermal energies [1].

In the first measurement campaign, ^{3}He was investigated by exciting microwave transitions between the ground state hyperfine states. This enabled us to determine the nuclear g-factor, the electronic g-factor and the zero field ground state hyperfine splitting of ^{3}He with a precision of 5*10 -10, 3*10 -10 and 2*10 -11, respectively [2].

Our measurement constitutes the first direct and most precise determination of the ^{3}He nuclear magnetic moment. The result is of utmost relevance for absolute precision magnetometry, as it allows the use of He NMR probes as an independent new standard with much higher accuracy. In addition, the comparison to advanced theoretical calculations enables us to determine the size of the ^{3}He nucleus with a precision of 2.4*10 -17 m.

In future, we aim at a direct determination of the bare nuclear magnetic moment of ^{3}He to be compared to the bound state result. For this measurement, it is essential to implement new methods and technology such as sympathetic laser cooling and a high precision voltage source based on Josephson junctions [3]. The latest results, status and the future prospect of the experiment will be presented.

References

[1] A Mooser et al., J. Phys.: Conf. Ser. 1138, 012004 (2018)
[2] A. Schneider et al., Nature 606, 878 (2022)
[3] A. Schneider et al., Ann. Phys. 531, 1800485 (2019)

Contact:
Andrea Graham
Institut für Physik
graham@uni-mainz.de