# Theory of the magnetic moments and hyperfine splitting of $^{3}He^{+}$

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In an external magnetic field, the ground state of the $^{3}He^{+}$ ion is split into into four sublevels due to the combined hyperfine splitting and Zeeman effect. By measuring transition frequencies between these sublevels, it is possible to determine the $g$-factor of the bound electron, the ground-state hyperfine splitting as well as the shielded magnetic moment of the nucleus [1].
In this work, we present the theoretical calculations of the nuclear shielding constant, the ground-state hyperfine splitting and the bound-electron $g$-factor [2]. The theoretical uncertainty of the bound-electron $g$-factor is dominated by the uncertainty of the fine-structure constant $\alpha$. This would allow an independent determination of $\alpha$ in future, provided that the experimental precision can be improved accordingly [3]. Combining the experimental value for the shielded nuclear magnetic moment and the theoretical value for the nuclear shielding constant, we extracted the magnetic moment of the bare nucleus with unprecedented precision, enabling new applications in magnetometry. Furthermore, we extracted the nuclear Zemach radius from the experimental hyperfine splitting value, in tension with the established literature value [4].

References

[1] A. Mooser, A. Rischka, A. Schneider, et al., J. Phys. Conf. Ser. **1138**, 012004 (2018).

[2] A. Schneider, B. Sikora, S. Dickopf, et al., Nature **606**, 878 (2022).

[3] J. Zatorski, B. Sikora, S. G. Karshenboim, et al., Phys. Rev. A **96**, 012502 (2017).

[4] I. Sick, Phys. Rev. C **90**, 064002 (2014).