# Measurement of hyperfine structure and the Zemach radius in $^6\mathrm{Li}^+$ using optical Ramsey technique

Kelin Gao[a,b], Hua Guan[a,b], Yao Huang[a,b]

[a] *State Key Laboratory of Magnetic Resonance and Atomic and Molecular Physics, Innovation Academy for Precision Measurement Science and Technology, Chinese Academy of Sciences, Wuhan 430071, China*

[b] *Key Laboratory of Atomic Frequency Standards, Innovation Academy for Precision Measurement Science and Technology, Chinese Academy of Sciences, Wuhan 430071, China*

High precision spectroscopy of heliumlike ions such as $\mathrm{Li}^+$ provides an important platform in the search for new physics beyond the standard model [1, 2], and a unique measuring tool for nuclear properties [3]. The Zemach radius of the $^6\mathrm{Li}^+$ isotope with spin 1 is a particular case in point where there is a marked disagreement between the value obtained from nuclear structure models [4], and that derived from the atomic hyperfine structure (hfs) coupled with high precision atomic theory [5, 6].

In this presentation, we report the measurement results of hfs in the $2\,^3S_1$ and $2\,^3P_J$ states of $^6\mathrm{Li}^+$, with smallest uncertainty of about 10 kHz. We investigate the $2\,^3S_1$–$2\,^3P_J$ $(J = 0, 1, 2)$ transitions in $^6\mathrm{Li}^+$ using the optical Ramsey technique and achieve the most precise values of the hyperfine splittings of the $2\,^3S_1$ and $2\,^3P_J$ states. The present results reduce the uncertainties of previous experiments by a factor of 5 [7] for the $2\,^3S_1$ state and a factor of 50 [8] for the $2\,^3P_J$ states, and are in better agreement with theoretical values. Combining our measured hyperfine intervals of the $2\,^3S_1$ state with the latest quantum electrodynamic (QED) calculations, the improved Zemach radius of the $^6$Li nucleus is determined to be 2.44(2) fm, with the uncertainty entirely due to the uncalculated QED effects of order $m\alpha^7$. The result is in sharp disagreement with the value 3.71(16) fm determined from simple models of the nuclear charge and magnetization distribution. We call for a more definitive nuclear physics value of the $^6$Li Zemach radius.

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