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Hyperfine and fine structure measurements of the 2 ^{3}S and 2 ^{3}P states of ^{7}Li^{+1}

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— Precision spectroscopy of Li$^+$ is a promising tool to test QED and measure fundamental constants. Here, we investigate the hyperfine and fine structures of 2 ^{3}S and 2 ^{3}P in ^{7}Li$^+$ using saturated fluorescence spectroscopy based on a ˜500 eV metastable ion beam. We measure the 2 ^{3}S$_1$ $\leftrightarrow$2 ^{3}P$_{0,1,2}$ transitions in ^{7}Li$^+$. The widths of ˜50 MHz in FWHM are determined by Lamb dips, which are generated by two counter-propagating lasers perpendicular to the Li$^+$ beam. With a triple nested loop scanning method, the long-term drift and systematic uncertainties are reduced or eliminated. The systematic uncertainties caused by the Doppler effect, line profile, laser power, frequency calibration and Zeeman effect are evaluated, giving a total uncertainty $<$100 kHz. For the 2 ^{3}S hyperfine splittings, the accuracy is close to the previous works. For the 2 ^{3}P fine and hyperfine splittings, our values are one order of magnitude more accurate than the previous experiments and have similar accuracy to the theoretical values.

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