Large associative ionization cross-section for low lying states of Li

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We observe a high rate of Li_2^+ formation via resonant excitation of ^{7}Li atoms to low-lying 2P and 3S states. It was observed in a dilute Magneto-optical trap (MOT) (average atomic separation $\approx$ 10 μm, $T \approx 500$ μK) of ^{7}Li formed at the center of a co-operational ion trap. The overlaps in the Potential Energy Curves (PECs) of neutral Li_2 and the Li_2^+, together with the quadratic dependence of Li_2^+ formation rate on the density of MOT, point towards associative ionization (AI) as the formation pathway [1]. We use the parametric excitation technique to not only identify these ions as Li_2^+ but also decipher the entire chain reaction:

$$\mathrm{Li}(3S) + \mathrm{Li}(2P) \rightarrow \mathrm{Li}_2^+ + e \rightarrow \mathrm{Li}^+ + \mathrm{Li} + e.$$

We study the photo-dissociation (PD) of Li_2^+ in the presence of MOT light. Unlike the case of Rb_2^+ [2], we observe a few long-lived Li_2^+ in the ion trap. These ions are formed in the lower vibrational states of the $X\,^2\Sigma_g^+$ PEC, which have low PD rates towards the dissociation continuum of the lowest $^2\Sigma_u^+$ state for the 670 nm wavelength. This observation offers an opportunity to co-trap Li_2^+ with other alkali species for further cold-chemistry studies. The significant AI rate of Li_2^+ suggests a large cross-section for this process. We carried out measurements to determine the AI cross-section to be very high ($\approx \pi(1000\,a_0)^2$) [1]. This is interesting, given that the participating atoms are not in high-lying Rydberg states [3].

References

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