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### **Photoassociation of ultracold polar molecules in the rovibrational ground state<sup>1</sup>**

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Ultracold LiCs molecules in the absolute ground state  $X^1\Sigma^+$ ,  $v''=0$ ,  $J''=0$  are formed via a single photo-association step starting from laser-cooled atoms. The selective production of  $v''=0$ ,  $J''=2$  molecules with a 50-fold higher rate is also demonstrated. The rotational and vibrational state of the ground state molecules is determined in a setup combining depletion spectroscopy with resonant- enhanced multi-photon ionization time-of-flight spectroscopy. Using the determined production rate of up to  $5 \times 10^3$  molecules/s, we describe a simple scheme which can provide large samples of externally and internally cold dipolar molecules. We analyze the formation of ultracold LiCs molecules in the rovibrational ground state through photoassociation into the  $B^1 \Pi$  state. Absolute rate constants for photoassociation at large detunings from the atomic asymptote are determined and are found to be surprisingly large. The photoassociation process is modeled using a full coupled-channel calculation for the continuum state, taking all relevant hyperfine states into account. The enhancement of the photoassociation rate is found to be caused by an increased amplitude of the singlet scattering wave function at the inner turning point of the lowest triplet state  $a^3\Sigma^+$ . This perturbation can be ascribed to the existence of a broad Feshbach resonance at low scattering energies. Our results elucidate the important role of couplings in the scattering wavefunction for the formation of deeply bound ground state molecules via photoassociation.

<sup>1</sup>Work performed in collaboration with J Deiglmayr, A Grochola, M Repp, K Mortlbauer, C Gluck, J Lange, R Wester, O Dulieu (Laboratoire Aime Cotton, Orsay, France), P Pellegrini, R Cote (University of Connecticut, Storrs, USA)