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Coherent Transfer of Photoassociated Molecules into the Rovibrational Ground State

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Recently, there have been impressive advances in methods of creating ultracold molecules from ultracold atomic gases. One of the key technologies used there is Stimulated Raman Adiabatic Passage (STIRAP), which has been successfully used for transferring Feshbach molecules into the rovibrational ground state. Since STIRAP relies on quantum coherence, it is unclear if STIRAP is also useful for non-polarized sample, like photo-associated molecules in a magneto-optical trap. Here we report on the SITRAP transfer of weakly bound molecules produced by photoassociation (PA). Laser cooled 41K and 87Rb atoms were first photo-associated into loosely-bound molecules in the $X^1\Sigma$ potential. Using v=41, J=1 level in the $(3)^1\Sigma$ potential as an intermediate level, we succeeded in transferring molecules in the v=91, J=0 level into the absolute ground state ($X^1\Sigma$, v=0, N=0). High-resolution spectroscopy based on the coherent transfer revealed the hyperfine structure of both weakly-bound and tightly-bound molecules. Our results show that a pure sample of ultracold ground-state molecules is achieved via the all-optical association of laser-cooled atoms, opening possibilities to coherently manipulate a wide variety of molecules.

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