Coherent optical association of single molecules

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We report coherent association of a single NaCs molecule in an optical tweezer through an optical Raman transition. By selecting a deeply bound intermediate state, we suppress the scattering loss during the transfer process. Starting from atoms in their relative motional ground state, we achieve optical transfer efficiency of 50% . The molecule we create have a zero-field binding energy of 770MHz and lifetime up to 1ms . We demonstrate that coherent creation of ground state single molecule is possible, even without Feshbach resonance or narrow optical transition.

Trapped neutral molecules, assembled in an array of optical tweezers, are a promising platform to study quantum infoqrmation and quantum simulations.

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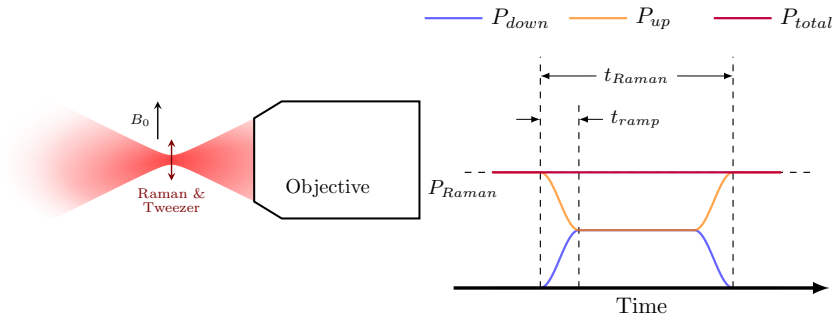

FIG. 1. Optical creation of single molecule from single atoms in tweezer. (A) Schematics of the Raman transition. (B) Geometry and polarization of trap and Raman beam relative to the bias magnetic field. (C) Molecule formation pulse sequence. The tweezer initially consists of only up leg power. This power is smoothly ramped down and the down leg power ramped up over $10\mu s$ while maintaining the total power of the tweezer.

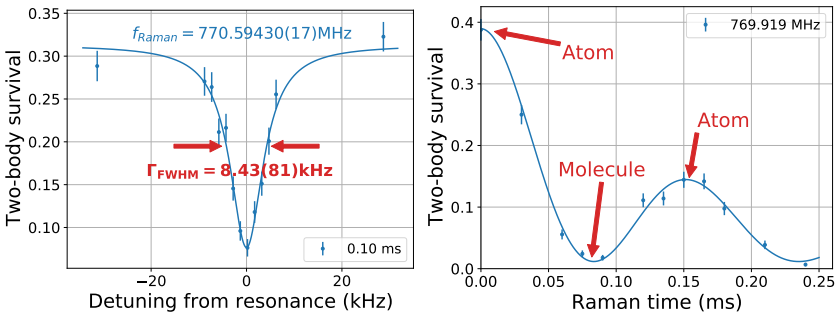

FIG. 2. (A) Raman resonance from atomic state to molecular state, showing Fourier limited linewidth. (B) Rabi oscillation on resonance

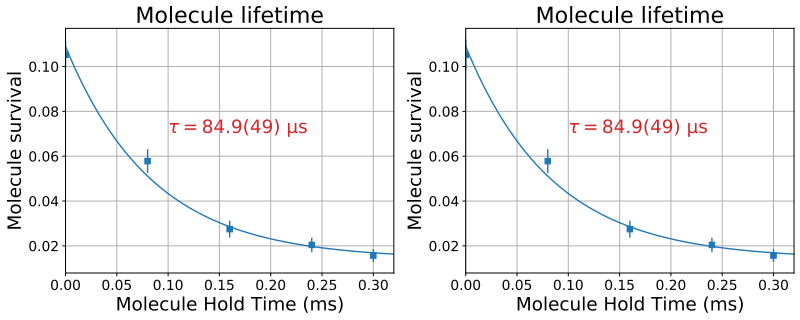

FIG. 3. (A) Molecule lifetime in 15 mW of trap depth (B) Two-body atom lifetime in 15 mW of trap depth