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Coherent control of a photo-chemical reaction with ultracold atoms in quantum superposition H. ESAT KONDAKCI, DAVID BLASING, CHUAN-HSUN LI, YONG CHEN, Purdue University — Ultracold atoms with precisely controlled internal degrees of freedom offer a variety of opportunities in ultracold quantum chemistry. Here, we demonstrate coherent control of chemical processes with Rb-87 Bose-Einstein condensates (BECs) via laser-induced molecular formation–photoassociation (PA). We prepare the condensates in a Raman-dressed spin-orbit-coupled state such that the spin quantum state of the Rb atoms is a superposition of different spin components in the F=1 hyperfine state. In contradistinction to reactions with BEC prepared in spin statistical mixture, the PA process results in identical fractional population losses of each spin components in the quantum superposition. Surprisingly, increasing Raman coupling suppresses the rate of molecular formation. We explain this phenomenon based on quantum destructive interference of two scattering channels with different spin combinations. We also discuss further studies of controlling PA rates by engineering initial quantum superposition states of atoms in our condensate.

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