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Experimental control of Quantum Chemistry with Interfering Pathways for Rb_2 Molecular Formation in a Bose-Einstein Condensate
HASAN ESAT KONDAKCI, CHUAN-HSUN LI, YONG P. CHEN, Purdue University — Ultracold atoms are amongst the best test beds to study coherent quantum chemistry due to the excellent ability to control the quantum states of the atoms. Here, we show coherent control based on quantum interference between reaction pathways in the ultracold molecule formation induced by a laser light, a process known as photoassociation (PA). We prepare optically trapped Rb-87 Bose-Einstein condensates (BECs) where the atoms are prepared in superpositions between different m_F spin states in the F=1 hyperfine state. By exploiting the quadratic Zeeman shift at low magnetic bias fields and a free evolution following a $\pi/2$ RF pulse inducing a spin population transfer, the evolution time controls the cumulative relative phase between the two reaction pathways (one for (m_F =0, m_F =0) pairs and the other for (+1,-1) pairs), resulting in an interferometric control of the normalized PA rate with near perfect visibility. Our method also provides a robust measurement technique to determine the quadratic Zeeman shift taking advantage of the cancellation effect due to the fast-oscillating phases in the scattering channel involving spin (+1,-1) pairs.

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