Quantum Physics

Triplet-singlet conversion in ultracold Cs$_2$ and production of ground state molecules

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We propose a process to convert ultracold metastable Cs$_2$ molecules in their lowest triplet state into (singlet) ground state molecules in their lowest vibrational levels. Molecules are first pumped into an excited triplet state, and the triplet-singlet conversion is facilitated by a two-step spontaneous decay through the coupled $A^{1}\Sigma_{u}^{+} \sim b ^{3}\Pi_{u}$ states. Using spectroscopic data and accurate quantum chemistry calculations for Cs$_2$ potential curves and transition dipole moments, we show that this process has a high rate and competes favorably with the single-photon decay back to the lowest triplet state. In addition, we demonstrate that this conversion process represents a loss channel for vibrational cooling of metastable triplet molecules, preventing an efficient optical pumping cycle down to low vibrational levels.

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