Optimal molecule production from Bose condensed atoms using non-linear magnetic field sweeps through a Feshbach resonance JAEY-OON JEONG, Department of Physics, Stevens Institute of Technology, Hoboken, NJ 07030, CHRISTOPHER P. SEARCH, Department of Physics, Stevens Institute of Technology, Hoboken, NJ 07030 — In most experiments involving conversion of ultracold atomic gases into molecules via a Feshbach resonance, a magnetic field, $B(t)$, is linearly swept across the resonance. In this case, Landau- Zener (LZ) theory predicts a high conversion efficiency if $\delta_{LZ} = \Omega_{R}^{2}/4|\Delta \mu \partial B/\partial t| > 1$, where $\Delta \mu$ is the difference between the atomic and molecular magnetic moments and $\Omega_{R}$ is the coupling between the atoms and molecules. $\delta_{LZ} > 1$ corresponds to adiabatic evolution for which the fraction of atoms converted into molecules is independent of the functional form of the sweep. For very fast linear sweeps such that $\delta_{LZ} \ll 1$, LZ theory predicts that almost no atoms are converted to molecules. Here we employ a genetic algorithm to determine the time dependence of the magnetic field that produces the maximum number of molecules when the duration of the sweep, $T$, is small enough for the evolution to be non-adiabatic, $\Omega_{R}^{2} < 4|\Delta \mu (B_{\text{initial}} - B_{\text{final}})|/T$. The optimal sweep through resonance shows that more than 95% of the atoms can be converted into molecules for sweep times as short as $4\pi/\Omega_{R}$ while the linear sweep results in a conversion of < 10%. The qualitative form of the non-linear optimal sweep is independent of the strength of the two-body interactions and the width of the resonance.

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