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Optimal molecule production from Bose condensed atoms using non-linear magnetic field sweeps through a Feshbach resonance JAEYOON 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 Ω_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, $\Omega_R^2 < 4|\Delta\mu(B_{initial} - B_{final})|/T$. 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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