Probing Coherence in a Cold Rydberg Gas

M.R. KUTTERUF, R.R. JONES, University of Virginia — We have used pulsed electric-field sequences to probe the coherence of dipole-dipole interactions in a MOT. Nanosecond dye lasers excite Rb atoms to the $|25s_{1/2}\rangle$ and $|33s_{1/2}\rangle$ states in an electric field. The field tunes the atoms so that the energy difference between $|25s_{1/2}\rangle$ and $|33s_{1/2}\rangle$ atom pairs is $\Delta$. For typical separations, the dipole-dipole coupling between atoms enables coherent population transfer from $|25s_{1/2}\rangle$ to $|24p_{1/2}\rangle$ at a rate comparable to $\Delta$. After a time $T$, an electric field step diabatically tunes the pair energy splitting to $-\Delta$. The atoms interact for an additional time $T$ and the population in the $|24p_{1/2}\rangle \rightarrow |34p_{3/2}\rangle$ state is measured. The pulse sequence enhances the $|24p_{1/2}\rangle \rightarrow |34p_{3/2}\rangle$ population relative to that obtained in a time $2T$ at fixed detuning, $\pm \Delta$. Sequences involving multiple resonance traversals lead to further enhancement, indicating that this effect is due to the coherence of the dipole-dipole interaction rather than excitation of different sets of atoms in the ensemble. The enhancement decays as $T$ approaches several microseconds. On this time scale, atomic motion may play a substantive role. This work is supported by NSF and AFOSR.