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Using Population Echoes to Explore Coherent Interactions in a Nearly Frozen Rydberg Gas M.R. KUTTERUF, R.R. JONES, Department of Physics, University of Virginia — Coherent interactions between atoms in a nearly frozen Rydberg gas have been investigated using an echo technique. Distinct Rydberg atom populations, $|25s_{1/2}>$ and $|33s_{1/2}>$, are laser-excited in a Rb MOT. A dipole-dipole coupling between pair states, $|25s_{1/2}>|33s_{1/2}>$ and $|24p_{1/2}>|34p_{3/2}>$, is then applied for a time,τ, using an electric field pulse which Stark shifts the pairs into resonance. After a delay, T, a second, identical field pulse is applied and the total population in the $|24p_{1/2}>|34p_{3/2}>$ state is measured. Interference fringes are observed as a function T, with a frequency determined by the zero-field energy separation, E, between the two pairs of states. As shown by Anderson et al [Phys. Rev. A 65, 063404], the interference fringes decay in a time $T_c \sim 100$ ns, which decreases for increasing Rydberg atom density. We show that a fast electric field step applied midway between the two interaction periods diabatically transports the pair state across the resonance, reversing the sign of E. In the absence of atom motion or decoherence, our signal should be identical to that for T=0, independent of static variations in E in the MOT. The coherence time can be extracted from measurements of this echo signal vs. T. This work has been supported by the NSF and the AFOSR.

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