Abstract Submitted
for the MAR12 Meeting of
The American Physical Society

Dephasing of multiparticle Rydberg excitations for fast entanglement generation[1] F. BARIANI, Y.O. DUDIN, T.A.B KENNEDY, A. KUZMICH, School of Physics, Georgia Institute of Technology, Atlanta, GA, 30332-0430, USA —
We propose an approach to fast entanglement generation based on Rydberg dephasing of collective excitations (spin waves) in large, optically thick atomic ensembles. Rather than trying to prevent multiple excitations via the Rydberg blockade mechanism, our idea is to allow multiple Rydberg level excitations to self-interact and dephase. The strong interaction required to dephase multiple excitations is induced by mixing adjacent, opposite-parity Rydberg levels with a microwave field. These levels experience resonant $1/r^3$ dipole-dipole interactions ($ns+n'p \to n'p+ns$) that extend over the whole ensemble in contrast to the weaker, short range $1/r^6$ Van der Waals coupling due to non-resonant processes ($ns+ns \to np+(n-1)p$). The interaction-induced phase shifts suppress the contribution of multiply excited states in phase matched optical retrieval. The dephasing mechanism therefore permits isolation and manipulation of individual spin wave excitations. High quality single photons can be created with $1/e$ maximum efficiency in few microseconds. The dephasing mechanism is shown to have favorable, approximately exponential, scaling. Required long coherence times are achieved via four-photon excitation and read-out of long wavelength spin waves.

[1]We aknowledge financial support from NSF and AFOSR.

Francesco Bariani
School of Physics, Georgia Institute of Technology,
Atlanta, GA, 30332-0430, USA

Date submitted: 26 Nov 2011 Electronic form version 1.4