Abstract Submitted
for the DAMOP17 Meeting of
The American Physical Society

Ultra-broadband photon storage in hot atomic barium vapor

BIN FANG, SHUAI DONG, University of Illinois at Urbana-Champaign, SETH MEISELMAN, OFFIR COHEN, University of Delaware, VIRGINIA LORENZ, University of Illinois at Urbana-Champaign — Quantum memories are critical in quantum computing and quantum communication, where they enable synchronization and deterministic photon output. Here we experimentally demonstrate storage of THz-bandwidth optical pulses in a hot atomic barium vapor using the off-resonance Raman protocol, indicating its potential for an ultra-broadband quantum memory. The large energy splitting in barium between the ground and storage states of $\sim$ 340 THz enables storage of $<$ 100 fs photons, leading to a time-bandwidth product $>$ 1000 and minimal thermal population in the storage state, resulting in low noise in single-photon operation. Our preliminary results show storage of 500 fs photons with an efficiency of 0.4% at barium densities of $5.1 \times 10^{19}\,\mathrm{m}^{-3}$. As a next step we are amplifying the control field and anticipate substantial improvement in efficiency. To date, researchers have shown storage of GHz-bandwidth photons in atomic systems and THz-bandwidth photons in molecular and solid state systems, but not broadband storage in the telecom range. Barium has a transition between state $6s6p\ ^1P_1$ and $6s5d\ ^1D_2$ at telecom wavelengths, making it feasible for telecom photon storage if one prepares the ground state $6s^2\ ^1S_0$ as the storage state.

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Date submitted: 27 Jan 2017 Electronic form version 1.4