Preserving photon qubits in an unknown quantum state with Knill Dynamical Decoupling – Towards an all optical quantum memory\(^1\)

MANISH K. GUPTA, Hearne Institute for Theoretical Physics, Department of Physics and Astronomy, Louisiana State University, Baton Rouge, Louisiana 70803, USA., ERIK J. NAVARRO, Department of Physics, California State University, Chico, Chico, CA 95929-0202, USA., TODD A. MOULDER, JASON D. MUELLER, ASHKAN BALOUCHI, KATHERINE L. BROWN, HWANG LEE, JONATHAN P. DOWLING, Hearne Institute for Theoretical Physics, Department of Physics and Astronomy, Louisiana State University, Baton Rouge, Louisiana 70803, USA. — The storage of quantum states and its distribution over long distances is essential for emerging quantum technologies such as quantum networks and long distance quantum cryptography. The implementation of polarization-based quantum communication is limited by signal loss and decoherence caused by the birefringence of a single-mode fiber. We investigate the Knill dynamical decoupling scheme, implemented using half-wave plates in a single mode fiber, to minimize decoherence of polarization qubit and show that a fidelity greater than 99% can be achieved in absence of rotation error and fidelity greater than 96% can be achieved in presence of rotation error. Such a scheme can be used to preserve any quantum state with high fidelity and has potential application for constructing all optical quantum memory, quantum delay line, and quantum repeater.

\(^1\)The authors would like to acknowledge the support from the Air Force office of Scientific Research, the Army Research office, and the National Science Foundation.

Manish Kumar Gupta
Hearne Institute for Theoretical Physics,
Department of Physics and Astronomy,
Louisiana State University, Baton Rouge, Louisiana 70803, USA.

Date submitted: 22 Jan 2015
Electronic form version 1.4