Abstract Submitted
for the MAR15 Meeting of
The American Physical Society

Optical Control of Semiconductor Quantum Dot Spin Qubits with Microcavity Exciton-Polaritons SHRUTI PURI[1], PETER L. MCMAHON, Ginzton Laboratory, Stanford University, YOSHIHISA YAMAMOTO[2], Ginzton Laboratory, Stanford University and National Institute of Informatics, Tokyo —
Topological surface codes demand the least stringent threshold conditions and are most promising for implementing large quantum algorithms. Based on the resource requirements to reach fault tolerance, we develop a hardware platform for large scale quantum computation with semiconductor quantum dot (QD) electron spin qubits. The current proposals for implementation of two-qubit gates and quantum non demolition (QND) readout in a QuDOS (Quantum Dots with Optically Controlled Spins) architecture suffer from large error rates. In our scheme, the optical manipulation of the QD spin qubits is carried out using their Coulomb exchange interaction with optically excited, spin-polarized, laterally confined quantum well (LcQW) exciton-polaritons. The small mass of polaritons protects them from interaction with their solid-state environment (phonons) and enables strong coupling between spin qubits separated by a few microns. Furthermore, the excitation manifold of the QD is well separated from that of the LcQW polaritons, preventing a spin-flip event during readout. We will outline schemes for implementing fast, high-fidelity, single qubit gate, two-qubit geometric phase gate and single-shot QND measurement and analyze important decoherence mechanisms.

[1]The work being presented was carried out at Stanford University. Currently the author is at University of Sherbrooke, Canada
[2]The work being presented was carried out at Stanford University. Currently the author is in Riken, Japan.

Shruti Puri
University of Sherbrooke

Date submitted: 13 Nov 2014 Electronic form version 1.4