

# Condensed Matter Physics Seminar Series

## Realizing Lattice Surgery on Two Distance-Three Repetition Codes with Superconducting Qubits

Andreas Wallraff

*Department of Physics, ETH Zurich, Switzerland*



Quantum error correction is needed for quantum computers to be capable of fault-tolerantly executing algorithms using hundreds of logical qubits. Recent experiments have demonstrated subthreshold error rates for state preservation of a single logical qubit. In addition, the realization of universal quantum computation requires the implementation of logical entangling gates. Lattice surgery offers a practical approach for implementing such gates, particularly in planar quantum processor layouts. In this work, we demonstrate lattice surgery between two distance-three repetition-code qubits [1] by splitting a single distance-three surface-code qubit [2]. Using a quantum circuit fault-tolerant to bit-flip errors, we achieve an improvement in the value of the decoded ZZ logical two-qubit observable compared to a similar non-encoded circuit. By preparing the surface-code qubit in initial states parametrized by a varying polar angle, we evaluate the performance of the lattice surgery operation for non-cardinal states on the logical Bloch sphere and employ logical two-qubit tomography to reconstruct the Pauli transfer matrix of the operation. In this way, we demonstrate the functional building blocks needed for lattice surgery operations on larger-distance codes based on superconducting circuits.

Since January 2012 Andreas Wallraff is a Full Professor for Solid State Physics in the Department of Physics at ETH Zurich. He joined the department in January 2006 as a Tenure Track Assistant Professor and was promoted to Associate Professor in January 2010. Previously, he has obtained degrees in physics from Imperial College of Science and Technology, London, U.K., Rheinisch Westfälische Technische Hochschule (RWTH) Aachen, Germany and did research towards his Masters degree at the Research Center Jülich, Germany.

**Friday, May 23rd at 10 AM**  
**4-330 PAB**