Quantum error correction with trapped Calcium ions

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In this talk we will report on our recent progress in realizing quantum algorithms on a string of trapped $^{40}Ca^{+}$ ions. In particular, we will focus on recent implementations of quantum error correction (QEC) protocols.

The first part of this talk will focus on the implementation of a 3-qubit quantum error correction code that corrects for single qubit phase-flip errors [1]. In the algorithm we use coherent operations for the correction of qubit errors and optical pumping for resetting the ancilla qubits. These techniques allow us to apply the QEC algorithm repetitively. We test the characteristics of this QEC algorithm in different dephasing environments.

The second part of the talk covers the reversal of a quantum measurement. The strong measurement of a quantum state is a non-reversible process that projects the system onto the eigenstates of the measurement operator. Therefore, it is in general not possible to reconstruct the state prior to the measurement. However, a measurement projection can also be regarded as a qubit error which can be rectified by quantum error correction techniques. We report on the experimental realization of such quantum measurement reversal by QEC. In particular, we adapt the previous 3-qubit quantum error correction code and show that it is capable to fully reverse the measurement projection of one of the three qubits.

References

[1] P. Schindler, et al., Experimental Repetitive Quantum Error Correction, Science 332, 1059 (2011).