TOPICS IN COHERENT STATE QUANTUM COMPUTATION AND STATE PURIFICATION

Abstract

by

Hilma Helena Macedo de Vasconcelos

This dissertation discusses mainly transmission of coherent state qubits, generation of cat states, and entanglement purification of any stabilizer state. A quantum computer is any device for computation that makes direct use of distinctively quantum mechanical phenomena, such as superposition and entanglement, to perform operations on data. The elementary carriers in quantum computation and information are the quantum bits, or *qubits*. In contrast to classical bits, qubits can be in every superposition of the states $|0\rangle$ and $|1\rangle$. This means that a vector describing a qubit may be any vector in a two dimensional Hilbert space.

In this dissertation, we review a method for constructing a linear optical quantum computer using coherent states of light as the qubits, developed by Ralph, Gilchrist, Milburn, Munro, and Glancy. We show how an universal set of logic operations can be performed using coherent states, beam splitters, photon counters, and a source of superpositions of coherent state, called "cat states". We also discuss the principal source of errors for this scheme and then present this author's analysis of the behavior of teleportation or Z gate when a non-maximally entangled Bell state is used. We describe several different schemes to generate cat states and make an analysis of these schemes in a realistic experimental environ-

ment subject to problems such as photon loss, detector inefficiency, and limited strength of nonlinear interactions.

Next, we consider that photon loss is the principal decoherence mechanism that affects a coherent-state based qubit transmission though a long optical fiber, and show how the errors introduced during transmission can be corrected in two different ways to encode the qubit. Lastly, we present a method for multipartite entanglement purification of any stabilizer state shared by several parties. In this protocol, each party measures the stabilizer operators of an error correction code on his or her qubits, exchange their syndrome results, correct errors, and decode to obtain the desired purified state.