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Fault-tolerant, nondestructive measurement of logical operators and quantum teleportation in large stabilizer codes

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Fault-tolerant quantum computation seeks to perform large calculations by protecting quantum information against decoherence using quantum error-correcting codes. Such schemes have been widely studied, but the resources needed to actually perform a fault-tolerant computation are daunting. In principle, it may be possible to reduce this overhead by using large block codes with significantly higher rates. Logical gates can be done in such a scheme by teleporting the logical qubits between code blocks. Logical teleportation can be done fault-tolerantly by measuring a particular set of logical operators. This measurement involves preparing an entangled ancillary state and doing a transversal circuit between the codeword and the ancilla. We study this procedure, and show that a wide range of such measurement protocols exist. There is a trade-off between the size of of the ancilla and the robustness against errors; for a large codeword, it may be fruitful to use a larger ancilla that has greater error-correcting power.