

**CMSC 691Q**  
**QUANTUM TELEPORTATION EXERCISES**

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- (1) Indicate in detail how Alice can use the standar teleportation protocol to teleport a qubit in the state

$$|\psi\rangle = \frac{(4 + 3i)|0\rangle + (4 - 3i)|1\rangle}{5\sqrt{2}}$$

to Bob. Show all intermediate states, and also all unitary transformations and observables used by Alice and Bob.

- (2) Devise a quantum protocol for teleporting two qubits in the arbitrary state

$$|\psi\rangle = a|00\rangle + b|01\rangle + c|10\rangle + d|11\rangle ,$$

where

$$|a|^2 + |b|^2 + |c|^2 + |d|^2 = 1 .$$

Can the standard quantum teleportation protocol be used twice to accomplish this?

- (3) Devise a quantum teleportation protocol for teleporting two qubits whose state is always of the form

$$|\psi\rangle = a|00\rangle + b|11\rangle ,$$

where

$$|a|^2 + |b|^2 = 1 .$$

Can the protocol of problem 2) be simplified for states of this form?