ON THE QUANTUM TELEPORTATION SUPERIORITY IN NOISY ENVIRONMENT

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1 The Question: Do we really need quantum teleportation (QT)?

QT → Pre-Shared Entangled State → Prior distribution of that state → **Need Quantum Channel for the distribution, and it can be a noisy channel**

Why not directly send the to-be-teleported state through the channel instead of using it for entangled-state pre-distribution?

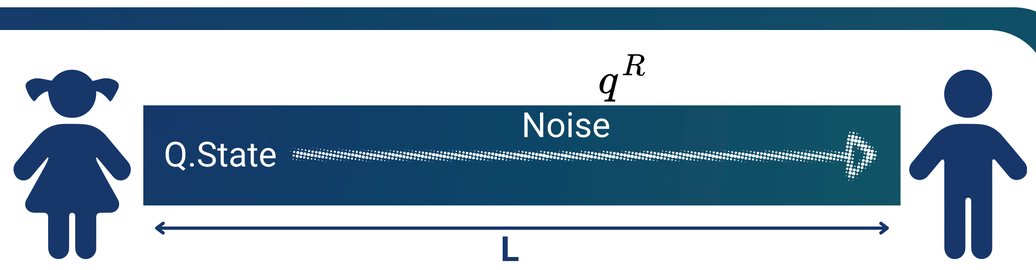
Quantum Teleportation (QT) is often considered superior, especially in quantum networks. However, if the primary goal is simply to transmit a quantum state from one point to another, direct transmission becomes comparable, since both approaches can accomplish the same task.

LET'S COMPARE!

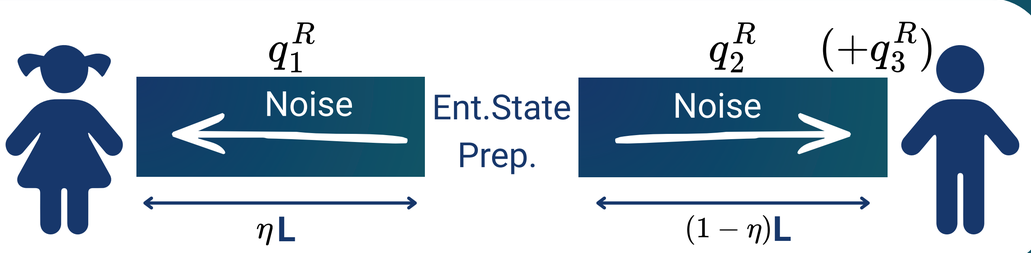
QT **VS** Direct Transmission (DT)

2 The method: comparing the noise effect during DT and QT's quantum channel

DT:



QT:



Types of noise used:
Bit-Flip, Phase-Flip, Depolarizing, Amplitude-Damping, Phase-Damping

Assumption for the noise parameters:

Distance-dependent noise model:

$$q^R \propto L, \quad q_1^R \propto \eta L, \quad q_2^R \propto (1-\eta)L$$

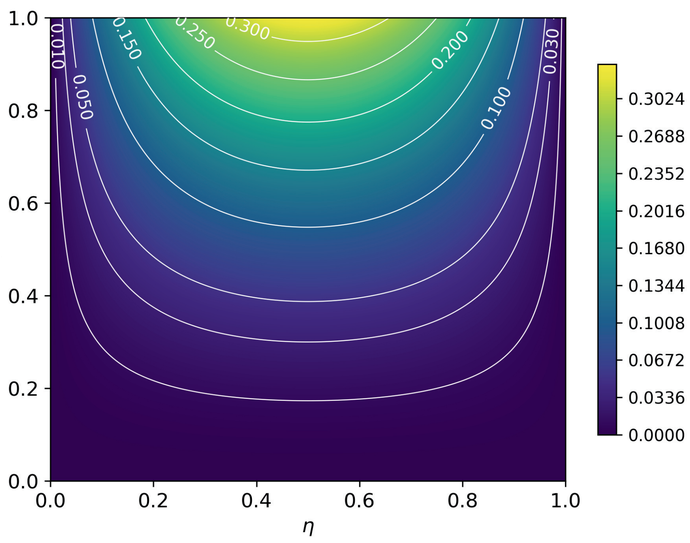
Time- dependent noise model:

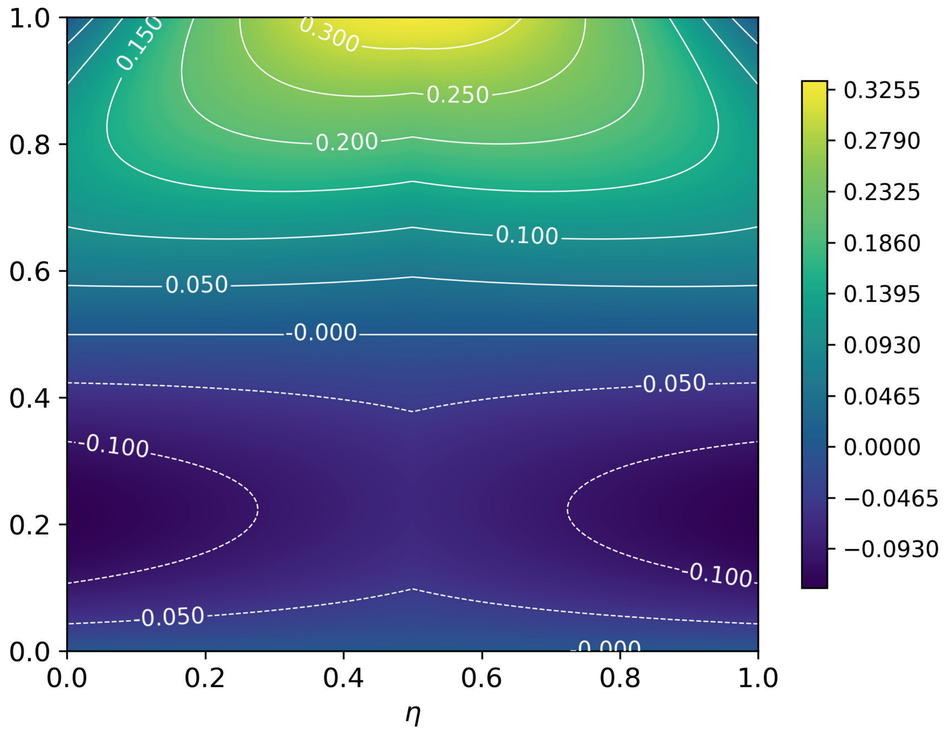
$$q^R \propto \frac{L}{c}; q_1^R \propto \frac{\max\{\eta,(1-\eta)\}L}{c}; q_2^R \propto \frac{\max\{\eta,(1-\eta)\}L}{c}; q_3^R \propto \frac{L}{c}$$

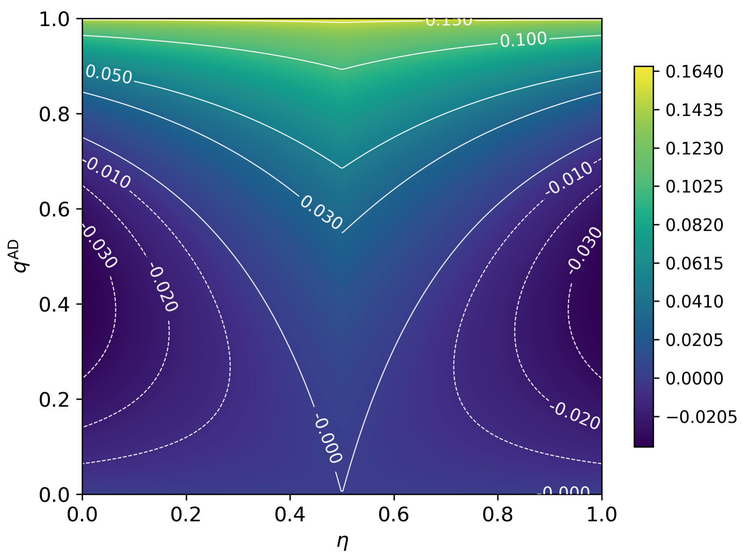
3 The Results: Quantum Teleportation is not always superior in Time-dependent noise model

$$\Delta^R_{distance-dependent} = \mathcal{F}^R_{distance-dependent} - \mathcal{F}^R_{DT}$$ ✗

$$\Delta^R_{time-dependent} = \mathcal{F}^R_{time-dependent} - \mathcal{F}^R_{DT}$$ ✓







- It was found that teleportation is superior for the distance-dependent model, while this is not the case for the time-dependent model.
- In the time-dependent model, we observed that teleportation is superior if the decoherence rate parameter is relatively high and inferior for relatively low values.
- It can be interpreted as follows: more noise leads to better teleportation performance (in comparison with direct transmission).

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