

## Quantum Portal: A Qubit Teleportation Engine

Welcome, Quantum Sorcerer — you've just opened the gateway to a simulation of quantum teleportation using Bell states, tensor decompositions, and multi-qubit systems. This engine allows you to teleport arbitrary quantum states, including 1-qubit and 2-qubit systems, using Qiskit and statevector math.

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### What Does It Do?

- Single-Qubit Teleportation via a Bell Pair.
  - Two-Qubit Teleportation using:
    - Tensor decomposition + recombination (tensor\_mode)
    - Double Bell state protocol (bellmode)
  - Fidelity calculation, Bloch visualization, and state display.
  - An animated spin-up intro for extra flair.
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### The Quantum Math Behind It

#### 1. Teleporting a Single Qubit

A standard Bell state teleportation protocol for:

$$|\psi\rangle = \alpha|0\rangle + \beta|1\rangle$$

We use entanglement, CNOT and H gates, followed by classical correction (X/Z gates based on measurement).

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#### 2. Teleporting Two Qubits

##### a) Tensor Product Mode (Simulation-Only):

We decompose a 2-qubit state:

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

into two single-qubit teleports and reconstruct the full state using Kronecker product. This is not directly implementable on hardware but is perfect for simulator studies and ML pipelines.

##### b) Bell Mode:

Uses two Bell pairs and the `partial_trace` of the original statevector to teleport each qubit independently. The final state is rebuilt with:

```
final_state = kron(phi0, phi1)
```

This is a **physically realizable approach** and better mimics true quantum hardware teleportation.

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## How to Use

Run the script:

```
python quantum_portal.py
```

You'll be prompted for complex coefficients.

Example:

Enter alpha: 1

Enter beta: i

The code auto-normalizes inputs and will:

- Teleport your qubit state
  - Show the final statevector
  - Compute fidelity
  - Launch a mini animation to spin up the portal
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## Functions Overview

- `teleport_single_qubit_state`: Teleports a 1-qubit state.
  - `teleport_user_qubit`: CLI interface for 1-qubit teleportation.
  - `teleport_twoqubit_tensor_mode`: Simulates 2-qubit teleportation via decomposition.
  - `teleport_twoqubit_bellmode`: Teleports two qubits using two Bell states.
  - `display_state`: Prints amplitudes of final state.
  - `show_bloch`: Visualizes a single qubit on the Bloch sphere.
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## Fidelity Checks

Uses the formula:

$$\text{Fidelity} = |\langle \psi_{\text{expected}} | \psi_{\text{actual}} \rangle|^2$$

This helps compare how close the teleported output is to the original quantum state.

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### Simulation Notes

- All teleportation uses Qiskit's Aer simulator and Statevector calculations.
  - Tensor mode is a simulation trick — useful for theory and classical-quantum hybrid compilers.
  - Bell mode is closer to real-world quantum network protocols.
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### Attribution

- Powered by [Qiskit](#)
  - Built by a quantum-obsessed student with zero lab access
  - Inspired by teleportation protocols in IBM Quantum Lab
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### Disclaimer & Future Fixes

If you encounter any errors, inaccuracies, or bugs in this quantum portal simulator, please note that:

- This project is a work-in-progress.
- It was built by a 19-year-old developer with no direct access to quantum hardware or lab infrastructure.
- Future versions will aim to fix known issues and enhance performance based on feedback and learning.

Kindly ignore minor imperfections for now and enjoy the exploration into quantum teleportation!