INTRO TO QUANTUM COMPUTING

Week 18 Lab

SUPERDENSE CODING

<insert TA name>

<insert date>

- Canvas attendance quiz

- Pre-lab zoom feedback

- Lab content

- Post-lab zoom feedback

Canvas attendance quiz passcode: 5586

- Please log into Canvas and answer your lab section's quiz (using the password posted below and in the chat).
  - This is lab number:
  - Passcode:

- **Question:** Please rate the **level of difficulty** of the work in this course

- **This quiz is not graded, but counts for your lab attendance!**

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On a scale of 1 to 5, how would you rate your understanding of this week's content?

- 1 –Did not understand anything
- 2 – Understood some parts
- 3 – Understood most of the content
- 4 – Understood all of the content
- 5 – The content was easy for me/I already knew all of the content

In lecture this week, we discussed multi-qubit states and tensor products

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- Implementing superdense coding on qiskit

  - State preparation and encoding circuit

  - Decoding circuit

  - Putting it all together – complete protocol

- Preparing the psi- bell state*

*Optional content

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KEY TAKEAWAYS

- Superdense coding allows Alice to send Bob a classical message consisting of **2 bits by transferring only 1 qubit**. A prerequisite for superdense coding is that Alice and Bob share a 2-qubit entangled state.

- In superdense coding, Alice prepares one of 4 Bell states to encode her message by applying single qubit gates to her qubit. Then, she sends her qubit to Bob.

- After receiving Alice's qubit, Bob applies a **Bell measurement** on both qubits to decode Alice's measurement. In this measurement, he first apples a CNOT gate and then an H gate to undo the "common" part of the state preparation circuit. Finally, he measures the 2 qubits. Bell measurements distinguish between the 4 Bell states with 100% probability.

- Quantum teleportation can be thought of as the inverse of superdense coding.

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- [Video on superdense coding from Prof. Michael Nielsen](#) (thanks to Douglas Beveridge for linking this on Piazza!)

- [Qiskit textbook page on superdense coding](#)

- [Qiskit textbook page on quantum teleportation](#)

- [Experimental demonstration of quantum teleportation](#)

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After this lab, on a scale of 1 to 5, how would you rate your understanding of this week's content?

- 1 – Did not understand anything
- 2 – Understood some parts
- 3 – Understood most of the content
- 4 – Understood all of the content
- 5 – The content was easy for me/I already knew all of the content

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