17.02. Demonstration of an all-optical quantum controlled-NOT gate. J.L. O'Brien, G.J. Pryde, A.G. White, T.C. Ralph, D. Branning. Nature 426, 264 (2003)

Presenter (10 min):

Sketch the key result.

Questions:

1. What are the basic requirements for quantum computers? What types of gates are necessary?
2. What are the advantages/disadvantages of single photon qubits?
3. What are the basic properties and requirements of the KLM protocol?
4. What are QND measurements? What is the proposed realization?
5. What is spatial/path enconding of qubits? What is polarization encoding?
6. What is the difference between classical and non-classical interference made in the paper?
7. Why does the control photon cause a phase shift for the target photon?
8. How is this phase shift converted to a bit flip? Do you se similarities to the Rydberg blockade?
9. What is the success probability of the gate? How is a successful operation detected?
10. Why is phase stability of the setup so important (and challenging)?
11. Can you easily map between conceptual setup and real setup?
12. Why is in sufficient to measure the correct gate operation for the computational basis states?
13. How could the non-classical interference be improved?
14. How is the entanglement of two qubits shown and why is it important?
15. What do the terms "Fidelity," "Tangle," and "Linear entropy" mean?
16. What is quantum state tomography and how many measurements are needed to reconstruct the density matrix?
17. How can you verify the operation of a classical/quantum gate and what is the main error present?
18. What are the remaining challenges for building an optical quantum computer?