TLS - The Physics of a Two-Level-System: Introduction to Quantum Information Processing using the IBM Quantum Experience

Signature Sheet

Student's Name _____ Partner's Name _____

Before the Lab See main text. **Pre-Lab Discussion Questions**

It is your responsibility to discuss this lab with an instructor before your first day of your scheduled lab period. This signed sheet must be included as the first page of your report. Without it you will lose grade points. You should be prepared to discuss at least the following before you come to lab:

1. what is a two-level-system, discuss at least three different physical systems (technologies) where two-level-systems can be controlled well.
2. What technology is used in this course.
3. What is the electrical circuit used to create a Josephson junction qubit ? What is the energy eigen-spectrum of the circuit ? Which levels constitute the qubit ?
4. How is a qubit controlled: develop intuition from a spin-1/2 system with magnetic moment in a magnetic field, how can the qubit be rotated, how can we find the expectation value of the qubit along various axes if we can "only" measure along the z axis ?
5. What is the most general state of a qubit ? What is the most general unitary transformation ?
6. What is the time evolution of a qubit initially in $|0\rangle$ under the following conditions:
   - Constant irradiation of the qubit at its resonant frequency.
   - Constant irradiation of the qubit near its resonant frequency.

   Either you can use your intuition or evaluate the equations given in the lab-write-up.
7. Optional: What is entanglement ? How can we use a controlled-NOT operation and single-qubit control to create the states $(|00\rangle \pm |11\rangle)/\sqrt{2}$, $(|01\rangle \pm |10\rangle)/\sqrt{2}$?

Instructor the prelab was discussed with: _____ Date _____

Completed before the first day of lab? (Circle one) Yes / No

Mid-Lab Discussion Questions

1. Show Rabi-flops simulated with the aer-backend.
2. Show the results of an experiment where you scanned the excitation frequency on either the armonk or the casablanca device. What is the qubit frequency?
3. Explain what a Ramsey experiment is and how it can be used to determine the qubit frequency accurately. What is the expected resolution?

Instructor the midlab was discussed with: _____ Date _____

Completed before the last day of the lab? (Circle one) Yes / No