

CLAIMS

1. A quantum system, comprising:
a qubit array comprising a plurality of qubits;
a bus resonator coupled between at least one pair of qubits in the qubit array; and
a switch coupled between the at least one pair of qubits.
2. The quantum system of claim 1, wherein:
the switch comprises a coupling resonator having a Josephson Junction (JJ), and
the switch is integrated with the bus resonator.
3. The quantum system of any one of the preceding claims, wherein the switch comprises a gate that is coupled to an electron system that is tunable by a voltage on the gate.
4. The quantum system of claim 3, wherein the electron system is configured to change an inductance based on a voltage on the gate.
5. The quantum system of any one of claims 3 to 4, wherein the gate is configured to tune the switch between (i) a low inductance state with a first critical current and (ii) a high inductance state with a second critical current, wherein the second critical current is lower than the first critical current.
6. The quantum system of any one of the preceding claims, wherein:
the switch has a first state that supports a supercurrent; and
the first switch has a second state that supports a high resistance and no supercurrent.
7. The quantum system of any one of claims 3 to 6, wherein the voltage on the gate is operative to change an inductance of the JJ.
8. The quantum system of any one of claims 3 to 7, wherein the switch comprises two or more superconductors that are separated by the electron system.
9. The quantum system of any one of claims 3 to 8, wherein the electron system comprises graphene.

10. The quantum system of any one of claims 1 to 9, wherein the switch is a voltage-controlled super current switch.
11. The quantum system of any one of claims 1 to 10, further comprising, for at least one qubit of the qubit array, a switch coupled between the at least one qubit and a readout resonator of the qubit array.
12. The quantum system of claim 11, wherein a combination of the switches between qubit pairs and qubits and readout resonators are configured to multiplex individual qubits in the array such that each qubit is individually controlled and independent of qubit frequency.
13. The quantum system of any one of the preceding claims, wherein:
 - the qubit array is part of a plurality of qubit arrays in a first layer; and
 - the plurality of qubit arrays of the first layer are each isolated by one or more switches.
14. The quantum system of any one of the preceding claims, wherein there is asymmetry in the qubit arrays between at least two layers of the plurality of layers.
15. The quantum system of any one of the preceding claims, wherein the quantum system comprises a plurality of layers, each having at least one qubit array separated by one or more switches from adjacent layers.
16. The quantum system of any one of the preceding claims, wherein two or more qubits in the qubit array have a substantially similar qubit frequency.
17. The quantum system of any one of the preceding claims, wherein the multiple layers are stacked on top of one another by way of bump bonding.
18. A method of controlling a quantum system, comprising:
 - providing a qubit array having a plurality of qubits;
 - coupling a bus resonator between each pair of qubits in the qubit array; and

at least one of:

separating at least one qubit pair of the qubit array by way of a Josephson Junction (JJ) switch, or

separating at least one qubit of the qubit array from a readout resonator by way of a second JJ switch.

19. The method of claim 18, further comprising changing an inductance of an electron system of a gate of the JJ switch by applying a voltage on the gate.

20. The method of any one of claims 18 to 19, further comprising separating two or more superconductors by the electron system of the JJ switch.

21. The method of any one of claims 18 to 20, further comprising multiplexing individual qubits by a plurality of switches including the JJ switch and the second JJ switch in the array, such that each qubit is individually controlled and independent of qubit frequency.

22. The method of any one of claims 18 to 21, further comprising:
stacking a plurality of qubit arrays on a plurality of layers; and
individually controlling each qubit of the plurality of layers by a plurality of switched and independent of qubit frequency.

23. A quantum system, comprising:
a qubit array comprising a plurality of qubits;
a bus resonator coupled between each pair of adjacent qubits in the qubit array; and
at least one of:
a switch coupled between each qubit pair of the qubit array; or
for at least one qubit of the qubit array, a switch between the at least one qubit and a readout resonator of the qubit array.

24. The quantum system of claim 23, wherein:
the switch is integrated with a coupling resonator having a Josephson Junction (JJ);
each switch comprises a gate that is coupled to an electron system that is tunable by a voltage on the gate; and
the electron system is configured to change an inductance of the JJ based on a voltage on the gate.
25. The quantum system of any one of claims 23 to 24, wherein a combination of the switches between qubit pairs and qubits and readout resonators is configured to multiplex individual qubits in the array such that each qubit is individually controlled independent of qubit frequency.