CLAIMS

1. A method of operating a circuit quantum electrodynamics system that includes a physical qubit dispersively coupled to a quantum mechanical oscillator, the method comprising:

measuring a parity of a first state of the quantum mechanical oscillator;

subsequent to measuring the parity of the first state, measuring a parity of a second state of the quantum mechanical oscillator, the second state being different from the first state;

applying a first drive waveform to the quantum mechanical oscillator; and

applying a second drive waveform to the physical qubit concurrent with the application of the first drive waveform,

wherein the first drive waveform and the second drive waveform are selected based at least in part on a result of comparing the measured parity of the second state to the measured parity of the first state, and

wherein application of the first drive waveform and the second drive waveform, at least in part, transition the quantum mechanical oscillator from the second state back to the first state.

2. The method of claim 1, wherein the first and second states are superpositions of a same plurality of photon number states, and wherein the first and second states have different amplitudes.

3. The method of claim 2, wherein the first and second drive waveforms are configured based on a duration between measuring the parity of the first state and measuring the parity of the second state.

4. The method of claim 1, wherein measuring the parity of the first and second states each comprises measuring photon number parity modulo 2.

5. The method of claim 1, wherein the first state is a superposition of a plurality of photon number states.

6. The method of claim 5, wherein the first state is a superposition of two states that have equal mean photon numbers.

7. The method of claim 6, wherein the first state is a superposition of $|W_{\downarrow}\rangle$ and $|W_{\uparrow}\rangle$ given by:

$$\left|W_{\uparrow/\downarrow}\right\rangle = \frac{1}{\sqrt{2^N}} \sum_{p \text{ even/odd}}^{N+1} \sqrt{\binom{N+1}{p}} \left| p(S+1) \right\rangle,$$

where N and S are positive integers, and $|n\rangle$ denotes a photon number state with n photons.

8. The method of claim 6, wherein the first state is a superposition of two states that each have a first mean photon number, and wherein the second state is a superposition of two states that each have a second mean photon number, different from the first mean photon number.

9. The method of claim 7, wherein the first and second drive waveforms are configured based on the values of $|W_{\downarrow}\rangle$ and $|W_{\uparrow}\rangle$.

10. The method of claim 1, wherein the first and second drive waveforms are selected from a computer readable medium storing a plurality of previously determined drive waveforms.

11. The method of claim 1, wherein measuring the parity of the first and second states each comprises measuring the photon number parity modulo N, where N is an integer greater than 2.

12. The method of claim 1, wherein said transition of the quantum mechanical oscillator from the second state back to the first state does not pass through a ground state of the quantum mechanical oscillator.

13. The method of claim 1, wherein the quantum mechanical oscillator is a microwave cavity.

14. The method of claim 1, wherein the physical qubit is a transmon qubit.

15. A system, comprising:

a circuit quantum electrodynamics system that includes a physical qubit dispersively coupled to a quantum mechanical oscillator;

at least one computer readable medium storing a plurality of drive waveforms;

at least one controller configured to:

measure a parity of a first state of the quantum mechanical oscillator;

subsequent to measuring the parity of the first state, measure a parity of a second state of the quantum mechanical oscillator;

select a first drive waveform and a second drive waveform from amongst the stored plurality of drive waveforms based at least in part on a result of comparing the measured parity of the second state to the measured parity of the first state; and

at least one electromagnetic radiation source configured to:

apply the first drive waveform to the quantum mechanical oscillator; and

apply the second drive waveform to the physical qubit concurrent with the application of the first drive waveform.

16. The system of claim 15, wherein the first and second drive waveforms are configured based on a duration between measuring the parity of the first state and measuring the parity of the second state.

17. The system of claim 15, wherein measuring the parity of the first and second states each comprises measuring photon number parity modulo 2.

18. The system of claim 15, wherein measuring the parity of the first and second states each comprises measuring the photon number parity modulo N, where N is an integer greater than 2.

19. The system of claim 15, wherein application of the first and second drive waveforms is configured to transition the quantum mechanical oscillator from the second state back to the first state without passing through a ground state of the quantum mechanical oscillator.

20. The system of claim 15, wherein the quantum mechanical oscillator is a microwave cavity.

21. The system of claim 15, wherein the physical qubit is a transmon qubit.