Claims

1. An apparatus, comprising:

an integrated circuit including:

a plurality of sources including qubit sources and cluster sources; and

a plurality of controlled-Z gates, each controlled-Z gate from the plurality of controlled-Z gates connecting at least two sources from the plurality of sources,

the integrated circuit configured, during operation, to sequentially energize subsets of sources from the plurality of sources and to generate a Raussendorf lattice based on interactions between sources from the plurality of sources.

2. The apparatus of claim 1, wherein each controlled-Z gate from the plurality of controlled-Z gates is a two-qubit gate.

3. The apparatus of claim 1, wherein the cluster sources are 1D cluster sources.

4. The apparatus of claim 1, wherein, during operation of the integrated circuit, qubits emitted from the qubit sources become entangled with qubits emitted from at least one spatial neighbor of the qubit sources.

5. A system, comprising:

a plurality of optical circuits configured to generate light having a plurality of output states via Gaussian Boson sampling (GBS);

a plurality of photon number resolving detectors (PNRs) operatively coupled to the plurality of optical circuits, the plurality of PNRs configured to generate qubit clusters based on the plurality of output states;

a multiplexer operatively coupled to the plurality of PNRs, the multiplexer configured to perform multiplexing of the qubit clusters and to replace empty modes with squeezed vacuum states, thereby configured to generate light having a plurality of hybrid resource states; and

an integrated circuit operatively coupled to the multiplexer, the integrated circuit configured to entangle hybrid resource states from the plurality of hybrid resource states into a higher-dimensional cluster state that includes states for fault-tolerant quantum computation.

6. The system of claim 5, wherein the integrated circuit is configured to entangle the hybrid resource states from the plurality of hybrid resource states into the higher-dimensional cluster state without the use of reconfigurable linear optics.

7. The system of claim 5, wherein the higher-dimensional cluster state includes a three-dimensional macronodal lattice structure in one temporal dimension and two spatial dimensions.

8. The system of claim 5, wherein the higher-dimensional cluster state includes a three-dimensional lattice structure, and each site from a plurality of sites of the lattice structure includes at least four modes.

9. An apparatus, comprising:

an integrated circuit including:

a plurality of multi-mode sources; and

a plurality of beamsplitters operatively coupled to the plurality of multi-mode sources, each beamsplitter from the plurality of beamsplitters connecting at least two multi-mode sources from the plurality of multi-mode sources,

the integrated circuit configured, during operation, to sequentially energize subsets of multi-mode sources from the plurality of multi-mode sources and to generate a Raussendorf lattice based on interactions between multi-mode sources from the plurality of multi-mode sources and at least one homodyne measurement.

10. The apparatus of claim 9, wherein the Raussendorf lattice includes a first layer including a set of qubits of a first type and a second layer including a set of qubits of a second type different from the first type.

11. The apparatus of claim 9, wherein, during operation of the integrated circuit, qubits emitted from the plurality of multi-mode sources become entangled with qubits emitted from at least one spatial neighbor of the plurality of multi-mode sources.

12. The apparatus of claim 11, wherein the qubits emitted from the plurality of multi-mode sources further become entangled with previously-emitted modes and subsequently-emitted modes.

13. A method, comprising:

receiving an input vector of homodyne measurements and a noise model;

identifying, based on the input vector of homodyne measurements and the noise model, at least one direction having a noise level above a predetermined threshold;

performing a change-of-basis on the input vector of homodyne measurements, based on the identified at least one direction, to generate a first modified vector;

applying a transformation to the first modified vector, the transformation including a binning operation and a rounding operation, to generate a second modified vector;

undoing the change-of-basis based on the second modified vector, to return a candidate lattice point; and

generating a binary string based on the candidate lattice point, the binary string representing an interpreted qubit measurement outcome.

14. The method of claim 13, wherein the binning operation is based on a map from homodyne measurement outcomes to bit values.

15. The method of claim 13, wherein the change-of-basis is performed using a transformation matrix.

16. The method of claim 13, wherein the rounding operation includes rounding to an integer multiple of $\sqrt{\pi}$.

~~17. A method, comprising:~~

~~receiving an input vector of homodyne measurements;~~

~~performing a change-of-basis on the input vector of homodyne measurements, to generate a first modified vector;~~

~~applying a transformation to the first modified vector, the transformation including a binning operation and a rounding operation, to generate a second modified vector;~~

~~undoing the change-of-basis based on the second modified vector, to return a third modified vector;~~

~~modifying half-integer valued components of the third modified vector to yield a fourth modified vector *n*; and~~

~~taking n mod 2 = s to produce a string of bit values s.~~

~~18. The method of claim 17, wherein the binning operation is based on a map from homodyne measurement outcomes to bit values.~~

~~19. The method of claim 17, wherein the change-of-basis is performed using a transformation matrix.~~

~~20. The method of claim 17, wherein the rounding operation includes rounding to an integer multiple of $\sqrt{\pi}$.~~