Claims

1. A method of quantum error decoding, the 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 phase-space direction having a noise level above a predetermined threshold indicative of an error occurring;

performing a change-of-basis on the input vector of homodyne measurements, based on the identified at least one phase-space 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, the interpreted qubit measurement outcome at least in part representing at least one error-corrected homodyne measurement.

2. The method of quantum error decoding of claim 1, wherein the binning operation is based on a map from homodyne measurement outcomes to bit values.

3. The method of quantum error decoding of claim 1, wherein the change-of-basis is performed using a transformation matrix.

4. The method of quantum error decoding of claim 1, wherein the rounding operation includes rounding to an integer multiple of $\sqrt{\pi}$.

5. The method of quantum error decoding of claim 1, wherein:

the input vector of homodyne measurements is associated with at least one bosonic state and is obtained by performing a homodyne measurement on each of the at least one bosonic state; and

the method is performed, at least in part, by a bosonic decoder.

6. A method of quantum error decoding, the 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 phase-space direction having a noise level above a predetermined threshold indicative of an error occurring;

performing a change-of-basis on the input vector of homodyne measurements, based on the identified at least one phase-space 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 third modified vector;

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

taking $n \bmod 2 = s$ to produce a string of bit values s, representing error-corrected homodyne measurements.

7. The method of quantum error decoding of claim 6, wherein the binning operation is based on a map from homodyne measurement outcomes to bit values.

8. The method of quantum error decoding of claim 6, wherein the change-of-basis is performed using a transformation matrix.

9. The method of quantum error decoding of claim 6, wherein the rounding operation includes rounding to an integer multiple of $\sqrt{\pi}$.

10. The method of quantum error decoding of claim 6, wherein:

the input vector of homodyne measurements is associated with at least one bosonic state and is obtained by performing a homodyne measurement on each of the at least one bosonic state; and

the method is performed, at least in part, by a bosonic decoder.

11. A quantum error decoder, comprising:

a processor; and

a memory, storing instructions to cause the processor to:

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

identify, based on the input vector of homodyne measurements and the noise model, at least one phase-space direction having a noise level above a predetermined threshold indicative of an error occurring;

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

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

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

generate a binary string based on the candidate lattice point, the binary string representing an interpreted qubit measurement outcome, the interpreted qubit measurement outcome at least in part representing at least one error-corrected homodyne measurement.

12. The quantum error decoder of claim 11, wherein the memory further stores instructions to cause the processor to perform the binning operation based on a map from homodyne measurement outcomes to bit values.

13. The quantum error decoder of claim 11, wherein the memory further stores instructions to cause the processor to perform the change-of-basis using a transformation matrix.

14. The quantum error decoder of claim 11, wherein the memory further stores instructions to cause the processor to perform the rounding operation by rounding to an integer multiple of $\sqrt{\pi}$.

15. The quantum error decoder of claim 11, wherein the quantum error decoder includes a bosonic decoder and the input vector of homodyne measurements is associated with at least one bosonic state and is obtained by performing a homodyne measurement on each of the at least one bosonic state.

16. A quantum error decoder, comprising:

a processor; and

a memory, storing instructions to cause the processor to:

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

identify, based on the input vector of homodyne measurements and the noise model, at least one phase-space direction having a noise level above a predetermined threshold indicative of an error occurring;

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

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

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

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

take $n \bmod 2 = s$ to produce a string of bit values s, representing error-corrected homodyne measurements.

17. The quantum error decoder of claim 16, wherein the memory further stores instructions to cause the processor to perform the binning operation based on a map from homodyne measurement outcomes to bit values.

18. The quantum error decoder of claim 16, wherein the memory further stores instructions to cause the processor to perform the change-of-basis using a transformation matrix.

19. The quantum error decoder of claim 16, wherein the memory further stores instructions to cause the processor to perform the rounding operation by rounding to an integer multiple of $\sqrt{\pi}$.

20. The quantum error decoder of claim 16, wherein the quantum error decoder includes a bosonic decoder and the input vector of homodyne measurements is associated with at least one bosonic state and is obtained by performing a homodyne measurement on each bosonic state from the at least one bosonic state.