The Resurgence of the Linear Optics Interferometer — Recent Advances & Applications

Si-Hui Tan[1, *] and Peter P. Rohde[2, †]
[1]Singapore University of Technology and Design, 8 Somapah Road, Singapore
[2]Centre for Quantum Software & Information (CQSI), Faculty of Engineering & Information Technology, University of Technology Sydney, NSW 2007, Australia

(Dated: January 9, 2017)

Contents

I. Introduction 1

II. Mathematical background 1

III. Optical encoding of quantum information 1
A. Single-photons 1
1. Polarisation 1
2. Dual-rail 1
3. Time-bins 1
B. Continuous-variables 1
1. Coherent states 1
2. Squeezed states 1

IV. Efficient circuit decompositions of linear optics networks 1

V. Experimental implementation 1
A. State preparation 1
1. Single-photons 1
2. Bell pairs 1
3. Coherent states 1
4. Squeezed states 1
B. Linear optics networks 1
1. Bulk-optics 1
2. Waveguides 1
3. Time-bins 1
C. Measurement 2
1. Photodetection 2
2. Homodyning 2

VI. Applications for linear optics interferometry 2
A. Linear optics quantum computation 2
B. Boson-sampling 2
C. Quantum metrology 2
D. Encrypted quantum computation 2

VII. State of the art 2

VIII. Conclusion 2

Acknowledgments 2

I. INTRODUCTION

Si-Hui can colour code things she adds like this
And Peter can do it like this
Let's add comments and questions like this

*sihui_tan@sutd.edu.sg
†dr.rohde@gmail.com; URL: http://www.peterrohde.org

II. MATHEMATICAL BACKGROUND

Mathematical representation for LO networks, and very basic background on quantum optics
A idealized single photon in a quantum interferometer is described by its creation operator $\hat{a}^\dagger_{j,\alpha}$, where j is the path label and α is a quantum number that describes any internal degrees of freedom of the photon. The creation and annihilation operators satisfy the bosonic comutator relationship $[\hat{a}_{j,\alpha}, \hat{a}^\dagger_{k,\beta}] = \delta_{j,k}\delta_{\alpha,\beta}$. When multiple photons are present, they experience quantum interference when both quantum labels are the same.

A linear optical interferometer

III. OPTICAL ENCODING OF QUANTUM INFORMATION

A. Single-photons

1. Polarisation

2. Dual-rail

3. Time-bins

B. Continuous-variables

1. Coherent states

2. Squeezed states

IV. EFFICIENT CIRCUIT DECOMPOSITIONS OF LINEAR OPTICS NETWORKS

Discuss the Reck et al. decomposition

V. EXPERIMENTAL IMPLEMENTATION

A. State preparation

1. Single-photons

2. Bell pairs

3. Coherent states

4. Squeezed states

B. Linear optics networks

1. Bulk-optics

2. Waveguides

3. Time-bins

Discuss fibre-loop architecture

C. Measurement

1. Photodetection

Discuss number-resolved and bucket detectors, multiplexed detection, APDs, current micropillar detectors

2. Homodyning

VI. APPLICATIONS FOR LINEAR OPTICS INTERFEROMETRY

A. Linear optics quantum computation

B. Boson-sampling

C. Quantum metrology

Discuss NOON states - Heisenberg limited
Discuss MORDOR scheme

D. Encrypted quantum computation

VII. STATE OF THE ART

Discuss where experiments are at at the moment

VIII. CONCLUSION

Acknowledgments

P.P.R. is funded by an ARC Future Fellowship (project FT160100397).