



TO MAGNIFICO RETTORE OF UNIVERSITA' DEGLI STUDI DI MILANO

ID CODE 6434

I the undersigned asks to participate in the public selection, for qualifications and examinations, for the awarding of a type B fellowship at Dipartimento di Fisica

Scientist- in - charge: Prof. Alessandro Ferraro

[Sheron Blair]

CURRICULUM VITAE

PERSONAL INFORMATION

Surname	Blair
Name	Sheron

PRESENT OCCUPATION

Appointment	Structure
PhD student (Physics)	Queen's University Belfast

EDUCATION AND TRAINING

Degree	Course of studies	University	Year of achievement of the degree
Master's Degree	Applied Maths & Physics	Queen's University Belfast	2020 Grade: First class honours, 85%

FOREIGN LANGUAGES

Languages	Level of knowledge
English	Native speaker
French	Basic

AWARDS, ACKNOWLEDGEMENTS, SCHOLARSHIPS

Year	Description of award
2022	Professor James Caldwell Travel Scholarship - funding for participation in Como school and research visit to University of Milan
2022	Sir David Bates Memorial Trust Fund Award - funding for participation in Continuous-Variable Quantum Correlations Workshop in Copenhagen



2021	Purser Studentship - Postgraduate researcher in pure or applied mathematics at QUB judged as most likely to enhance the standing of the area in which they study
2020	PhD funding - Engineering and Physical Sciences Research Council, grant number 2442912
2020	Bates Prize - Master's student in Centre for Theoretical Atomic Molecular and Optical Physics at QUB with highest undergraduate mark subsequently pursuing research in the Centre
2020	Seagate Technology (Ireland) Prize - MSci Physics student with the best performance in Solid State modules at Levels 2, 3 and 4
2020	DegreePlus - Recognition of extracurricular experience gained during degree (peer mentor for first-year students)
2017 & 2018	Foundation Scholarships - Awards for performance in 1st and 2nd year exams
2017	STEM Performance Award - One of the top 50 students enrolled in a Science, Technology, Engineering or Mathematics course at QUB
2016	John Sinclair Porter Scholarship - Third-placed A-level entrant to QUB in 2016

TRAINING OR RESEARCH ACTIVITY

PhD in Physics: October 2020 - present (due to submit thesis in April)

Thesis title: Bosonic systems for quantum computing and open-system probing

Supervisors: Alessandro Ferraro & Mauro Paternostro

I have been researching bosonic systems for continuous-variable quantum computing, investigating the generation of logical Gottesman-Kitaev-Preskill (GKP) qubits in infinite-dimensional quantum systems such as photonic platforms. The goal is to show that a set of gates deemed universal according to the Braunstein-Lloyd notion of CV universality can be used to generate GKP states which are good enough for fault-tolerance. We construct a quantum circuit which takes the vacuum state as its input and applies repeating blocks of these Braunstein-Lloyd universal gates. Using the Strawberry Fields python library from Xanadu, we simulate a gate-based photonic quantum computer executing our circuit. We optimise the gate parameters to maximise the fidelity between the output of the circuit and the target GKP state.

We calculate the Glancy-Knill error probability, which is the probability of misidentifying computational basis states upon performing homodyne measurements. To determine whether the generated states are resources for fault-tolerant error-correction, we need to compare their error probability with the threshold of a discrete-variable error-correcting code. We choose the surface code, since its concatenation with the GKP code has been studied and a squeezing threshold for a fault-tolerant quantum memory has been identified in the case of infinite-energy GKP states. We convert the squeezing threshold to a threshold in error probability, and show that our finite-energy (physically realisable) GKP states, generated via Braunstein-Lloyd gates, have error probability below the threshold. This provides evidence to support the hypothesis that the Braunstein-Lloyd model of CV computation allows for fault-tolerant quantum error-correction.

I've also been working on linear response theory for studying non-unitary perturbations of open quantum systems evolving towards non-equilibrium steady states. We considered an open system comprised of two coupled quantum harmonic oscillators, and analytically calculated the steady-state covariance matrix and Heisenberg evolution of the observables whose response we want to investigate. We looked at the response of the system to perturbations affecting the properties of the environment, e.g. its temperature and squeezing. We showed that linear response, combined with a quantum probing



approach, can effectively provide valuable quantitative information about the perturbation and characteristics of the environment, even in cases of non-unitary dynamics.

During my PhD, I have completed 35 days of training, including:

- ARCHER2 Software Carpentry
- Small group teaching
- Giving presentations
- Getting the most out of arXiv
- How to peer review

CONGRESSES AND SEMINARS

Date	Title	Place
July 2023	(Poster) Gate-based quantum computation in photonic platforms via GKP codes.	Central European Workshop on Quantum Optics, University of Milan, Italy
September 2022	(Poster) Universal gate sets for continuous-variable quantum computation imply fault-tolerance	Quantum characterization and control of complex quantum systems, Lake Como School for Advanced Studies, Como, Italy
September 2022	(Contributed talk) Gate-based quantum computation in photonic platforms via GKP codes	Continuous-variable quantum correlations, Carlsberg Academy, Copenhagen, Denmark
June 2022	(Participant)	Quantum Thermodynamics Conference (Online)
November 2021	(Contributed talk) Fault-tolerance of the Braunstein-Lloyd notion of continuous-variable universality	Quantum Backstop II, Carrickdale Hotel, Dundalk, Ireland
May 2021	(Participant)	NONGAUSS Online Workshop: Twinning in non-Gaussian Physics for Quantum Technology
November 2020	(Participant)	Q-Turn online workshop: Changing Paradigms in Quantum Science

PUBLICATIONS

Articles in reviews
Nonequilibrium quantum probing through linear response, Phys. Rev. Research 6 , 013152 (2024)



OTHER INFORMATION

Tutoring:

Each year since 2020, I have been a demonstrator for the first-year maths module “Introduction to Algebra & Analysis”, formerly “Numbers, Vectors & Matrices”, teaching three tutorials per week to groups of 20-25 students. These tutorials have taken place both on-campus (2022-present), and online (2020/21). I have also marked homeworks, provided feedback, and led revision sessions prior to exams. In 2022 I attained Associate Fellowship of the Higher Education Academy, which is a recognition of teaching practice aligned with the UK Professional Standards Framework.

Declarations given in the present curriculum must be considered released according to art. 46 and 47 of DPR n. 445/2000.

The present curriculum does not contain confidential and legal information according to art. 4, paragraph 1, points d) and e) of D.Lgs. 30.06.2003 n. 196.

Please note that CV WILL BE PUBLISHED on the University website and It is recommended that personal and sensitive data should not be included. This template is realized to satisfy the need of publication without personal and sensitive data.

Please DO NOT SIGN this form.

Place and date: ____Belfast____, __06/03/24__