David K. Tuckett, BSc Open, BSc Wales, MSc Staffs, PhD Syd

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Nationalities:Australian, BritishLanguages:English – fluent, French – fluent

Summary

With an outstanding academic record in both physics and computer science, as well as extensive professional experience as a software engineer, I am now pursuing a career in quantum computing research. I currently work as a postdoctoral researcher in the Quantum Theory Group at the University of Sydney and regularly collaborate with researchers throughout Australia and worldwide.

My research focuses on quantum error correction (QEC) and fault-tolerant quantum computation. My recent papers [<u>1-5</u>] identify and exploit previously unknown symmetries of surface codes with experimentally prevalent noise models to achieve exceptionally high thresholds and low logical failure rates. This work is supported by a research-grade Python library that I developed to complete QEC simulations on National Computing Infrastructure HPC facilities.

I have also had a highly successful career in software engineering, culminating in 5 years working for CERN providing computing support to the LHC experiments. This has provided me with strong technical skills and more than 12 years of professional experience fulfilling the roles of developer, architect and team leader.

Education

03/16-04/20: The University of Sydney, Australia **Doctor of Philosophy in Physics**

- Thesis: Tailoring surface codes Improvements in quantum error correction with biased noise [6].
- Supervisors: Professor Stephen D. Bartlett, Professor Steven T. Flammia.
- First-author papers published in Physical Review Letters [<u>1,3</u>] and Physical Review X [<u>2</u>].
- Extensive Python library developed for QEC simulation: <u>https://qecsim.github.io/</u>
- Resource allocation grants on National Computing Infrastructure HPC facilities (2018, 2019, 2020).
- Australian Postgraduate Award scholarship for exceptional research potential (2016-2019).
- The John Makepeace Bennett Gift scholarship for excellence in nanoscience (2018-2019).
- EQUS Prize for best student paper (December 2018).
- Postgraduate Research Prize for outstanding academic achievement (July 2018).

11/04-12/14: The Open University, UK BSc Honours Physical Science – First-class

- 96.68% average mark. High distinctions (i.e. ≥90%) in all graded modules.
- Part-time study with full-time equivalence of 3.8 years.
- Dissertation within the field of quantum information on the subject of oblivious transfer.
- Institute of Physics undergraduate bursary awarded based on course performance (2008-2010).
- Peter Napier Prize for best performance in core physics module: The Physical World (2007).

09/96-05/98: Staffordshire University, Stafford, UK MSc Computing Science – Distinction

- A-grade average across all modules.
- Full-time study including 6 month industrial period at Brokat Infosystems AG, Germany.
- Dissertation within the field of genetic algorithms.
- 10/89-06/93: The University of Wales, Swansea, UK **BSc Honours Pure Mathematics 2ii**
- 09/87-06/89: Plymouth College of Further Education, Plymouth, UK **A-levels** (grade): Pure and Applied Mathematics (A), Physics (A), Economics (B).
- 04/85-06/87: Ivybridge Community College, Devon, UK **O-levels**: 8 at grade A or B, including Mathematics and English.

Professional Experience

12/19-present: The University of Sydney, Australia. Research Fellow (Quantum Theory)

My main role is to collaborate with colleagues and supervise students to produce first-class research in quantum information theory. Additionally, I leverage my expertise in software engineering to support research more generally within the group. Another important and very enjoyable aspect of my role is communicating our research to the wider community.

Research excellence:

- Focus on quantum error correction (QEC) and fault-tolerant quantum computation.
- Nature Communications paper [4] (2021): significant direct contribution and co-supervision of a student to demonstrate the highest yet fault-tolerant thresholds on a variant of surface code.
- arXiv preprint [5] (2021): collaboration with colleagues from Yale (USA) and YITP (Japan) to produce a realistic proposal for the near-term implementation of OEC using Kerr-cat gubits.
- High relevance to the roadmaps of industry leaders developing 2D topological codes.
- Australian Institute of Physics Medal for Postgraduate Excellence in Physics (November 2020).

Software engineering:

- Development of open-source software for QEC simulations (see https://gecsim.github.io/).
- Promotion and support of best-practice software development within the group.
- Resource allocation grant on National Computing Infrastructure HPC facilities (2021).

Communication:

- Presentations at QEC'19 and FTQT 2020 international conferences [7,8].
- Member of Australian Research Council EQUS outreach committee for high-school teachers.
- EQUS Node Research Fellow Representative, representing Sydney researchers within EQUS.

09/09-09/14: CERN, Geneva, Switzerland. Software Engineer (Python and Oracle)

I worked within the Experiment Support group, which is the interface between the IT department and the physics experiments at CERN. My role was to develop solutions for monitoring activity on the Worldwide LHC Computing Grid (WLCG). I collaborated closely with IT and physics colleagues, supervised fellows and summer students, and reported on our work within CERN and internationally.

- Design, development and operation of data transfer monitoring systems to ensure ATLAS experiment data is distributed to physicists around the world.
- Supervision of several fellows and summer students implementing WLCG monitoring systems.
- Reporting on our work at WLCG and LHC experiment workshops.
- Presentations of our work at the International Conference on Computing in High Energy and Nuclear Physics (CHEP) in Taipei (2010) and in New York (2012) [9,10,16].
- Three individual awards for extraordinary service.

I am extremely proud that my work at CERN, like that of many others, contributes in some part to advances within high energy physics, such as the discovery of the Higgs boson in 2012.

11/07-08/08: AGI Solutions, London, UK. Architect and Senior Developer (Java)

My role was architect and senior developer, responsible for all layers of an intranet media application enabling customer service managers to control the lifecycle of publishing campaigns. I also provided technical leadership and mentoring to the team, as well as liaising with end-users. I worked with an international team of developers, including remote workers, following an Agile methodology.

05/07-08/07: Imperial College, London, UK. Research Placement (Python)

Within the High Energy Physics Group, I worked on Ganga, a front-end for the management of jobs running on the LHC Computing Grid. I developed a module for periodic submission of analysis jobs and statistics reporting. My work was accepted by the team at CERN for inclusion in Ganga and my contribution was acknowledged in the official reference paper for Ganga.

02/07-05/07: AGI Solutions, London, UK. Architect and Senior Developer (Java) 01/03-12/06: Prima Solutions, Paris, France. Architect and Senior Developer (Java) Reef, Paris, France. Senior Developer (Java) 02/01-12/01: 05/99-10/00: e-Net Software, Bath, UK. Senior Developer (Java) 10/98-05/99: PricewaterhouseCoopers Kinesis, Swindon, UK. Software Engineer 03/97-09/97: Brokat Infosystems AG, Stuttgart, Germany. Software Engineer 01/96-02/96: SWEB Computing Department, Plymouth, UK. Development Tester Isca School of English, Exeter, UK. English Teacher (TEFL) 04/95-08/95:

Publications in Quantum Information Theory

1. D. K. Tuckett, S. D. Bartlett, S. T. Flammia,	
Ultrahigh error threshold for surface codes with biased noise,	
Phys. Rev. Lett. 120, 050505 (2018), [DOI: <u>10.1103/PhysRevLett.120.050505]</u>	(107 citations)

- D. K. Tuckett, A. S. Darmawan, C. T. Chubb, S. Bravyi, S. D. Bartlett, and S. T. Flammia, **Tailoring surface codes for highly biased noise**, *Phys. Rev. X* 9, 041031 (2019), [DOI:<u>10.1103/PhysRevX.9.041031</u>] (43 citations)
- 3. D. K. Tuckett, S. D. Bartlett, S. T. Flammia, and B. J. Brown,
 Fault-tolerant thresholds for the surface code in excess of 5% under biased noise,
 Phys. Rev. Lett. 124, 130501 (2020), [DOI:10.1103/PhysRevLett.124.130501] (37 citations)
- 4. J. P. Bonilla Ataides, D. K. Tuckett, S. D. Bartlett, S. T. Flammia, and B. J. Brown, **The XZZX surface code**, *Nat. Commun.* 12, 2172 (2021), [DOI:<u>10.1038/s41467-021-22274-1</u>] (16 citations)
- 5. A. S. Darmawan, B. J. Brown, A. L. Grimsmo, D. K. Tuckett, and S. Puri, **Practical quantum error correction with the XZZX code and Kerr-cat qubits**, *arXiv preprint* quant-ph (2021), [arXiv:2104.09539] (2 citations)

6. D. K. Tuckett,
 Tailoring surface codes: Improvements in quantum error correction with biased noise,
 Ph.D. thesis University of Sydney (2020), [DOI:10.25910/x8xw-9077]
 (2 citations)

Conferences in Quantum Information Theory

- FTQT 2020, Fault-Tolerant Quantum Technologies Workshop, Benasque, Spain (online), Resilience of tailored surface codes to biased noise, Invited speaker, [Recording: <u>https://youtu.be/ENNz0 IItZw</u>]
- 8. QEC'19, Fifth International Conference on Quantum Error Correction, London, UK, **Tailoring surface codes for highly biased noise**, *Contributing speaker*, [Recording: <u>https://youtu.be/d4m8wlfu1_g</u>]

Selected Publications in Computing for High Energy Physics

9. J. Andreeva, I. Dzhunov, E. Karavakis, L. Kokoszkiewicz, M. Nowotka, P. Saiz and D. Tuckett, Designing and developing portable large-scale JavaScript web applications within the Experiment Dashboard framework,

J. Phys.: Conf. Ser. 396, 052069 (2012), [DOI: 10.1088/1742-6596/396/5/052069] (17 citations)

 J. Andreeva, M. Devesas Campos, J. Tarragon Cros, B. Gaidioz, E. Karavakis, L. Kokoszkiewicz, E. Lanciotti, G. Maier, W. Ollivier, M. Nowotka, R. Rocha, T. Sadykov, P. Saiz, L. Sargsyan, I. Sidorova and D. Tuckett, Eventsing of the LHC Distributed Computing Systems.

Experiment Dashboard for Monitoring of the LHC Distributed Computing Systems, J. Phys.: Conf. Ser. 331, 072001 (2011), [DOI:<u>10.1088/1742-6596/331/7/072001</u>] (16 citations)

- J. Andreeva, M. Cinquilli, D. Dieguez, I. Dzhunov, E. Karavakis, P. Karhula, M. Kenyon, L. Kokoszkiewicz, M. Nowotka, G. Ro, P. Saiz, L. Sargsyan, J. Schovancova and D. Tuckett, Experiment Dashboard a generic, scalable solution for monitoring of the LHC computing activities, distributed sites and services, J. Phys.: Conf. Ser. 396, 032093 (2012), [DOI:10.1088/1742-6596/396/3/032093] (16 citations)
- J. Andreeva, A. Beche, S. Belov, D. Diguez Arias, D. Giordano, D. Oleynik, A. Petrosyan, P. Saiz, M. Tadel, D. Tuckett and I. Vukotic, Monitoring of large-scale federated data storage: XRootD and beyond,
 - *J. Phys.: Conf. Ser.* 513, 032004 (2014), [DOI:<u>10.1088/1742-6596/513/3/032004</u>] (11 citations)
- E. Karavakis, J. Andreeva, M. Cinquilli, I. Dzhunov, M. Kenyon, L. Kokoszkiewicz, P. Saiz, L. Sargsyan, and D. Tuckett,
 User-centric monitoring of the analysis and production activities within the ATLAS and CMS Virtual Organisations using the Experiment Dashboard system,
 Proc. Sci. EGICF12-EMITC2, 110 (2012), [DOI:10.22323/1.162.0110] (9 citations)
- 14. J. Andreeva, S. Campana, E. Karavakis, L. Kokoszkiewicz, P. Saiz, L. Sargsyan, J. Schovancova and D. Tuckett,
 - ATLAS job monitoring in the Dashboard Framework,

J. Phys.: Conf. Ser. 396, 032094 (2012), [DOI:<u>10.1088/1742-6596/396/3/032094</u>] (8 citations)

 J. Andreeva, A. Beche, S. Belov, I. Dzhunov, I. Kadochnikov, E. Karavakis, P. Saiz, J. Schovancova and D. Tuckett, Processing of the WLCG monitoring data using NoSQL,

J. Phys.: Conf. Ser. 513, 032048 (2014), [DOI: <u>10.1088/1742-6596/513/3/032048</u>] (7 citations)

J. Andreeva, D. Dieguez Arias, S. Campana, J. Flix, O. Keeble, N. Magini, Z. Molnar, D. Oleynik, A. Petrosyan, G. Ro, P. Saiz, M. Salichos, D. Tuckett, A. Uzhinsky and T. Wildish, Providing global WLCG transfer monitoring,

J. Phys.: Conf. Ser. 396, 032005 (2012), [DOI:<u>10.1088/1742-6596/396/3/032005</u>] (4 citations)

 J. Elmsheuser, F. Brochu, I. Dzhunov, J. Ebke, U. Egede, M. Jha, L. Kokoszkiewicz, H. C. Lee, A. Maier, J. Mościcki, T. München, W. Reece, B. Samset, M. Slater, D. Tuckett, D. Van der Ster and M. Williams,

Reinforcing user data analysis with Ganga in the LHC era: scalability, monitoring and user-support,

J. Phys.: Conf. Ser. 331, 072011 (2011), [DOI: 10.1088/1742-6596/331/7/072011] (4 citations)

Other Qualifications and Awards

11/20:	Australian Institute of Physics
	Postgraduate Excellence in Physics Medal 2020
12/18:	Australian Research Council Centre of Excellence for Engineered Quantum Systems
	EQUS Prize for best student paper
07/18:	University of Sydney, Australia
	Postgraduate Research Prize for outstanding academic achievement
07/18-09/19:	University of Sydney Nano Institute, Australia
	The John Makepeace Bennett Gift Scholarship for excellence in nanoscience
03/16-09/19:	Australian Commonwealth Government
	Australian Postgraduate Award for exceptional research potential
07/11, 12, 14:	CERN, Geneva, Switzerland
	3 Awards for Extraordinary Service
07/08-02/10:	Institute of Physics, UK
	Undergraduate Bursary for performance in BSc Honours Physical Science
01/07:	The Open University Department of Physics and Astronomy, UK
	The Peter Napier Prize for best performance in 2006 in course The Physical World
05/04:	Sun Microsystems
	Sun Certified Web Component Developer for Java 2 Enterprise Platform (96%)
04/02:	Sun Microsystems
	Sun Certified Programmer for Java 2 Platform (94%)
02/95-03/95:	International House, London, UK
	RSA/UCLES Certificate in Teaching English as a Foreign Language
08/93-07/94:	L'Université de Bourgogne, Dijon, France
	Diplôme supérieur d'études françaises (mention BIEN)