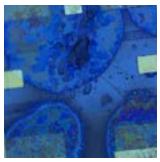
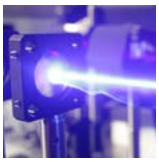
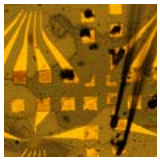
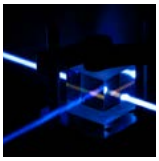




eQuS SPIN Newsletter

ARC CENTRE OF EXCELLENCE FOR ENGINEERED QUANTUM SYSTEMS

A message from the Centre Director

Welcome to the first issue of the new edition of the EQuS newsletter.

In a large multi institution centre such as EQuS, effective communication is an on-going challenge. I hope this newsletter goes some way to meeting that challenge.

In this issue you will find articles on new staff and students as well as features on CIs, postdocs, students and recent visitors. We will highlight a research program in each issue kicking off with one from our Macquarie node.

Please do get in contact with us if you would like to include a highlight in your research for a future issue.

Professor Gerard J. Milburn
Centre Director, Centre for Engineered Quantum Systems
An Australian Research Council Centre of Excellence

May 29

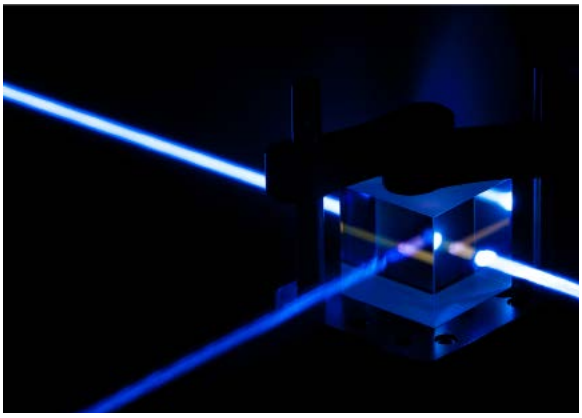
Have you signed up for the EQuS Winter School?

Registrations close on May 29!

Be featured on EQuS social media!

Email your news to equs.engagement@uq.edu.au

Don't forget to follow us on social media (search for ARC_EQuS on Twitter and Facebook).



WELCOME TO OUR NEW STUDENTS AND POST-DOCS

EQuS is an Australian Research Centre of Excellence. You will work with some of the best and brightest minds together to unravel the mysteries of the quantum world.

Honours recruits

Theodore Faros, University of New South Wales
Henry Stoke, University of Sydney
Wai Chuen Timothy Shen, University of Sydney
Alistair Robertson Milne, University of Sydney
Claire Edmunds, University of Sydney
Cameron Duncan, University of Sydney
William De Ferranti, University of Sydney
Matthew Allen, University of Sydney
Stephen Dona, University of Sydney

Masters by research:

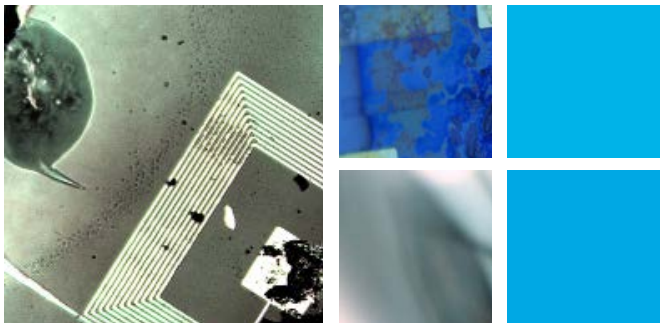
Reece Roberts, Macquarie University

PhD

Thomas Bell, University of Queensland
Ignazio Cristina, University of Sydney
Matthew van Breugel, Macquarie University
Andrew Wood, Macquarie University

Post-docs

Sandeep Mavadia, University of Sydney
Christopher Chubb, University of Sydney
Nicolas Funai, University of Sydney
Robin Harper, University of Sydney



RECENT PUBLICATIONS

Surface enhanced anti-Stokes one-photon luminescence from single gold nanorod
Nanoscale
Yingbo He, Keyu Xia, Guowei Lu, Hongming Shen, Yuqing Cheng, Yong-chun Liu, Kebin Shi, Yun-Feng Xiao, Qihuang Gong

Simple scheme for universal linear-optics quantum computing with constant experimental complexity using fiber loops
Physical Review A
Peter P. Rohde

Boson sampling with photons of arbitrary spectral structure
Physical Review A
Peter P. Rohde

Evidence for the conjecture that sampling generalized cat states with linear optics is hard
Physical Review A
Peter P. Rohde, Keith R. Motes, Paul A. Knott, Joseph Fitzsimons, William J. Munro, Jonathan P Dowling

Rapid readout of a register of qubits using open-loop quantum control
Physical Review A
Joshua Combes, Aaron Denney, Howard M. Wiseman

Observation of directly interacting coherent two-level systems in an amorphous material
Nature Communications
Jürgen Lisenfeld, G. J. Grabovskij, Clemens Müller, Jared H. Cole, Georg Weiss, Alexey V. Ustinov

Bounds on quantum communication via Newtonian gravity
New Journal of Physics
D Kafri, G J Milburn, J M Taylor

Single-qubit thermometry
Physical Review A
Sania Jevtic, David Newman, Terry Rudolph, T. M. Stace

Parity effect in Josephson junction arrays
Physical Review B
Jared H. Cole, Andreas Heimes, Timothy Duty, Michael Marthaler

Cryogenic Control Architecture for Large-Scale Quantum Computing
Physical Review Applied
J.M. Hornibrook, J.I. Colless, I.D. Conway Lamb, S.J. Pauka, H. Lu, A.C. Gossard, J.D. Watson, G.C. Gardner, S. Fallahi, M.J. Manfra, D.J. Reilly

Characterizing Quantum Dynamics with Initial System-Environment Correlations
Physical Review Letters
M. Ringbauer, C.J. Wood, K. Modi, A. Gilchrist, A.G. White, A. Fedrizzi

Phase-modulated decoupling and error suppression in qubit-oscillator
American Physical Society
T Green, M Biercuk

Multiscale entanglement renormalization ansatz for spin chains with continuously varying criticality
Physical Review B
Jacob C. Bridgeman, Aroon O'Brien, Stephen D. Bartlett, Andrew C. Doherty

The 3D split-ring cavity lattice: a new metastructure for engineering arrays of coupled microwave harmonic oscillators
New Journal of Physics
Maxim Goryachev, Michael E Tobar

Quantum Bovchner's theorem for phase spaces built on projective represenations
iopscience.iop.org
C Ferrie, N Dangniam

Dispersive readout of ferromagnetic resonance for strongly coupled magnons and microwave photons
Physical Review B
A Doherty, JM Hornibrook, JI Colless, ID Conway Lamb, SJ Pauka, H Lu, AC Gossard, JD Watson, GC Gardner, S Fallaji MJ Manfra , DJ Reilly

Measurements on the reality of the wavefunction
Nature Physics
M. Ringbauer, B. Duffus, C. Branciard, E. G. Cavalcanti, A. G. White, A. Fedrizzi

Strong coupling between diamond impurity centers and a three-dimensional lumped photonic microwave cavity
Physical Review B
Daniel L. Creedon, JeanMichel Le Floch, Maxim Goryachev, Warrick G. Farr, Stefania Castelletto, Michael E. Tobar

Squeezing-enhanced measurement sensitivity in a cavity optomechanical system
Annalen der Physik
Hugo Kerdoncuff, Ulrich B. Hoff, Glen I. Harris, Warwick P. Bowen, Ulrik L. Andersen

Robust and efficient quantum control
Physical Review A
C Ferrie, O Moussa

PROFILE

Michael Tobar
Chief Investigator
University of Western Australia

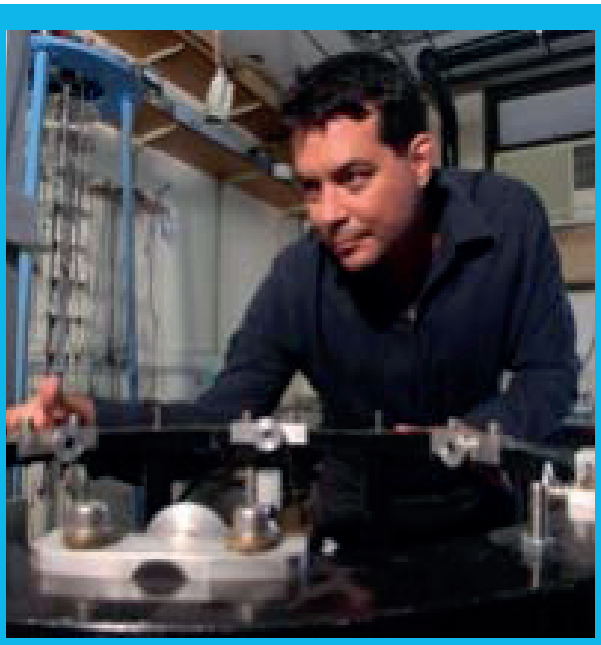
Professor Michael Tobar received his PhD degree in physics from the University of Western Australia in 1994. He is currently a Professor in the School of Physics.

Between 2009 and 2014, he completedly an Australia Research Council Laureate Fellowship. In 2014, Professor Tobar was also award the Cady Award (presented by the IEEE) and the Clunies-Ross award (presented by the Australian Academy of Science and Technology).

Michael has recieved a citation from the Australian Learning and Teaching Council for inspiring research students to reach their full potential and transform to successful research scientists through participation in ground-breaking research.

His research interests encompass the broad discipline of frequency metrology, precision and quantum measurements and precise tests of fundamental physics. He has co-authored more than 220 journal publications in these fields over his career.

Michael is the focal point of Australian participation in space experiments invovling precision clocks and oscillators.



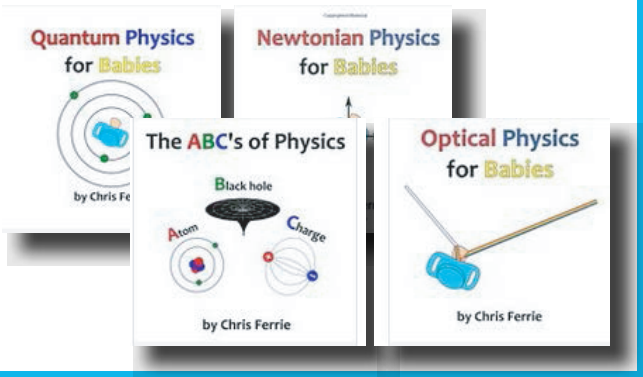
Chris Ferrie
Post-doc research
University of Sydney

Dr. Chris Ferrie received his PhD degree from the University of Waterloo, Canada in 2012. In 2013 and 2014 he was a Postdoctoral Fellow at University of New Mexico.

Chris has been a member of EQuS since moving to the University of Sydney in January 2015.

His research interests focus on Quantum Information Theory and Quantum Foundations. In June 2015, Doctor Ferrie will presesent at the EQuS Winter School to provide graduate students with an introduction to Quantum Information.

Chris is also a children's book author. His works include 'Quantum Physics for Babies' and 'The ABC's of Physics'. He believes it is never too early to introduce children to the wild and wonderful world of physics!



AWARDS

Congratulations to all ARC Future Fellows commencing in 2015.

Recipients include:

Arkady Fedorov

Tom Stace

Ian McCulloch

Any awards or grants for your node, please let us know at equs.engagement@uq.edu.au.

Andrew Wood
PhD Student
Macquarie University

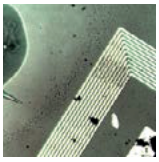
Andrew Wood has a Masters of Research in Physics and a Bachelors of Science with a major in Photonics.

Andrew joined EQuS in the beginning of 2014 during his second year of his Masters of Research. He studied with Thomas Volz's group at Macquarie University. Andrew was constructing a fabry-Perot fibre microcavity fabrication for experimentation into cQED.

He choose to research quantum optics as the systems looked interesting and exciting to work with.

Andrew's research interests are looking at quantum light-matter interactions in tunable micro-cavity systems, including but not exclusively, exciton-polaritons and nanodiamonds.

PROFILE



Tara Roberson
Communications and Engagement Officer
University of Queensland

Tara graduated with a Bachelors of Communication in 2013. She is currently completing a Masters of Science Communication at the University of Queensland. This degree focuses on academic and professional development in the theory and practice of science communication.

Tara has worked with various organisations (including a legume research facility, Inspiring Australia and the UQ Art Museum) to create tailored communication pieces (including podcasts, videos, social media campaigns and articles).

In her communications and engagement role at EQuS, Tara will improve the Centre's online presence through communication campaigns that showcase the Centre's world leading research.

VISITING ACADEMICS

OUTREACH SCHOOL VISIT April 29, 2015

The University of Queensland node recently hosted a group of secondary physics students from Mt. St. Michaels College, Ashgrove.

The day included lab tours in The Atom Optics Lab and The Optical Micromanipulation Lab as well as Three minute PhD and 'Working in Physics' presentations.

Student feedback

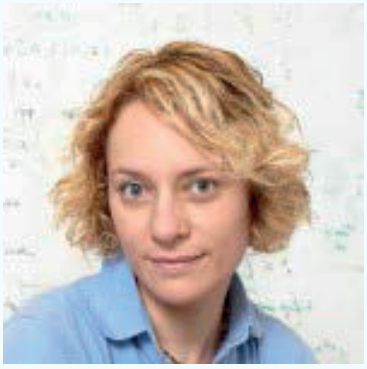
"I enjoyed learning about physics research and meeting research students."

"I enjoyed the fact that we were able to see professional physicists but also meet PHD students, so as to gain an understanding of what it would be like to study the subject in terms of a career path."

"I much appreciated gaining a better understanding of what I might do if I were to enter that particular field."

Stephanie Wehner

When: January 2015
Where: University of Queensland
Host CI: Gerard Milburn



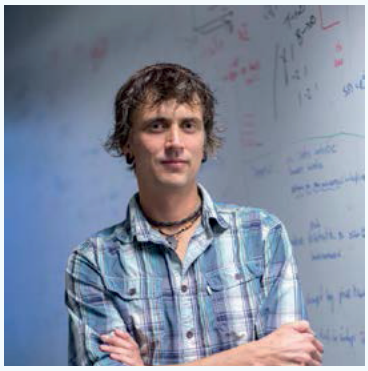
Stephanie Wehner is an Associate Professor in quantum information at QuTech, Delft University of Technology.

Her goal is to understand the properties of small particles – the laws of quantum mechanics – in order to construct bet ter networks and computers.

Quantum bits behave quite differently than classical bits, and allow us to solve tasks that are probably impossible for any classical device.

Terry Rudolph

When: January 2015
Where: University of Sydney
Host CI: Stephen Barlett

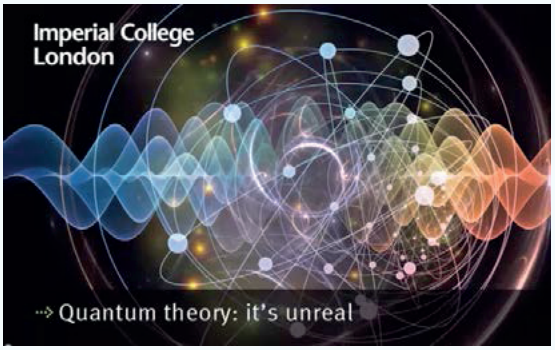


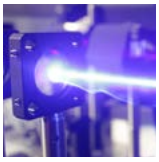
Terry Rudolph is a Professor of Quantum Physics at the Imperial College, London.

He is a theoretical physicist and works in Imperial College's Quantum Optics & Laser Science Group.

Following a PhD in quantum information. Terry began teaching the topic at the University of Toronto. After time as a postdoc in Vienna, he moved to Imperial College, London on an Advanced Fellowship.

Terry occasionally gives lectures on quantum physics. You can access his talk on how to construct a narrative over activity in the subatomic world through this link or clicking the image below.





EQuS News
Macquarie University

New research explores when quantum systems get critical

An international team of scientists from China and Australia have released research that has probed how quantum matter changes when it makes a 'quantum phase transition'.

The collaborators, Professor Haohua Wang's group in Zhejiang University, China, Professor Jason Twamley at the Centre for Engineered Quantum Systems, Macquarie University, and Professor Mang Feng's group for Bound-System Quantum Information Processing at Wuhan Institute of Physics and Mathematics, Chinese Academy of Sciences, have published their latest research result experimentally exploring a quantum phase transition.

> "Researchers have been intrigued for decades by the quantum counterpart."
>
> - Professor Jason Twamley, Centre for Engineered Quantum Systems, Macquarie University.

Exploring quantum phase transitions experimentally has, until recently, been thought to be impossible as most theories predict that one requires very large light-matter coupling strengths – so high that experiments have so far been unable to reach them. This stumbling block was circumvented in this work by continually driving the system with microwave radiation.

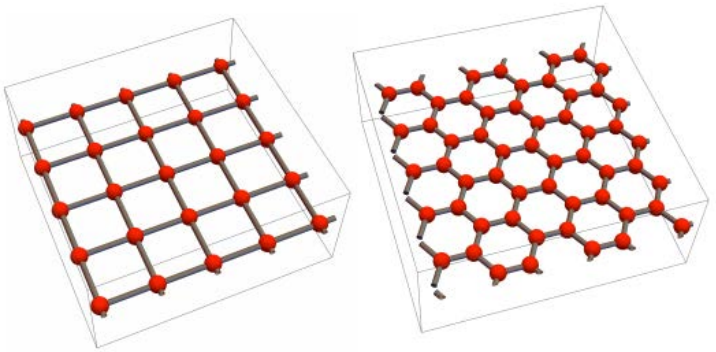
In the team's experiment they used a superconducting quantum chip containing four quantum bits (qubits), coupled to an integrated microwave superconducting cavity – essentially an electrical quantum superconducting circuit. By continually driving the electrical circuit and carefully measuring the quantum state of the qubits the researchers were able to observe the abrupt change from a 'normal phase' to a 'superradiant phase', of the quantum chip as they swept through the quantum phase transition.

"In the ordinary world we are all familiar with classical phase transitions when matter changes from one type of state to another, for example when solid water – ice – turns to liquid if we heat it or when we apply pressure to the ice when we ice skate," said Professor Jason Twamley.

"Researchers have been intrigued for decades by the quantum counterpart – or a quantum phase transition – where the quantum state of matter abruptly changes as you slowly change a quantity. A typical case is where the symmetry of the quantum state changes abruptly, for example, when it changes from a configuration with four-fold symmetry to one with six-fold symmetry," said Professor Twamley.

"It is suspected that quantum phase transitions also play a crucial role in various materials whose properties we wish to understand – for example, high temperature superconductors, so we can engineer them again to suit technology. This experiment is a first step towards a deeper understanding of the curious features of the quantum phase transition," said Professor Mang Feng.

Feng M., Zhong Y.P., Liu T., Yan L.L., Yang W.L. , Twamley J. and Wang H. 2015. Exploring the quantum critical behaviour in a driven Tavis-Cummings circuit. Nature Communications



A quantum phase transition is typically signaled by an abrupt change in a property of the quantum state of a system. Schematically for example, when the system switches abruptly from having a square-lattice symmetry (left), to an hexagonal-lattice symmetry (right).

Would you like your research news featured by EQuS?

Send the press release to equs.engagement@uq.edu.au

Don't forget: All post-docs and CIs are eligible to sign up as media experts on www.scimex.org.