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Date: Nov 2017

Academic Qualifications

PhD in Physics, California Institute of Technology (Caltech), USA — Aug2004–Sep2009
MEng in Applied Physics, Cornell University, USA — Aug2002–Jun2003
AB in Physics (*Summa Cum Laude*) & Mathematics (*Magna Cum Laude*) with *Distinction in all subjects*, Cornell University, USA — Aug1999–Jun2002

Professional Experience

Current position

Assistant Professor (Physics), Yale-NUS College (YNC), and Centre for Quantum Technologies (CQT), NUS

Past positions

Research Fellow, CQT, NUS (joint appointment) — Oct2009–Jun2013
Senior Member of Technical Staff, DSO National Laboratories, Singapore — Oct2009–Jun2013
Member of Technical Staff, DSO National Laboratories, Singapore — Aug2003–Aug2004

Research focus

Various physical aspects of quantum information and quantum computation (theory), with expertise in quantum error correction and fault tolerance, quantum noise, quantum state and parameter estimation, and physical implementation of quantum logical tasks.

Awards and fellowships

Graduate Research Assistantship, Caltech 2008–2009
Betty and Gordon Moore Fellowship, Caltech, 2004–2008
David Delano Clark Award (Best MEng project, AY2002/03, School of App & Eng Phys), Cornell U, 2003
Paul Hartman Prize in Experimental Physics (joint award by the Dept Phys and the School of App & Eng Phys), Cornell U, 2002
Defence Technology Training Award (undergrad scholarship), Singapore, 1999–2003

Seminars, conference talks, and posters

Invited talks

Quantum error correction and fault tolerance (two lectures), Institut Néel, Grenoble, France, Jun 2017.
Open system quantum error correction: an effective system-only noise map, Technische Universität München (Wolf group talk), Munich, Germany, Oct 2016.
Reliable maximum likelihood reconstruction for quantum tomography, Max-Planck Institute for the Science of Light, Erlangen, Germany, Oct 2016.
Reliable maximum likelihood reconstruction for quantum tomography, ICFO (Lewenstein group seminar), Barcelona, Spain, Aug 2016.
Open system quantum error correction: an effective system-only noise map, Central European Workshop for Quantum Optics, Crete, Greece, Jun 2016.
Aspects of quantum information, MajuLab Day, NTU, Singapore, May 2016.
Optimal error regions for quantum estimation, Applied Math Department seminar, Hanyang University, Korea, Dec 2015.
Fighting quantum noise, MajuLab UMI Kickoff Meeting, CQT, NUS, Jan 2015.
Is useful quantum computation really possible?, CQT (Englert group seminar), NUS, Mar 2014.
Transport in 1D revisited: A simple, exact solution for phase disorder, Albert-Ludwigs University of Freiburg, Freiburg, Germany, Jun 2013.
Multi-level, multi-photon processes: A hierarchy of approximations, Stuttgart University, Germany, Jun 2013.
Transport in 1D revisited: A simple, exact solution for phase disorder, Laboratoire de Physique et Modélisation des Milieux Condensés, Grenoble, France, Oct 2012.
Long-lived qubits in atomic systems, theory seminar at 6 institutes in France, Oct 2011: Laboratoire Kastler Brossel in Paris; Institut d'Optique in Orsay; Laboratoire de Physique et Modélisation des Milieux Condensés in Grenoble; Institut Néel in Grenoble; Department of Physics at ENS in Lyon; Institut Non-Linéaire de Nice in Nice.
The transpose channel – a generic recovery from noise, theory seminars at 2 institutes in France, Oct 2011: CEA-Saclay in Orsay; Laboratoire Physique de la Matière Condensé in Nice.
Entanglement is observable-induced, Applied Physics Lab, DSO National Laboratories, Singapore, 2008.
Preserved information in quantum processes, CQT Seminar, CQT, NUS, 2008.

Contributed talks

Approximate quantum error correction and fault tolerance (one lecture), Workshop on Quantum Information, Benasque, Spain, Jun 2017.

Superfast maximum likelihood reconstruction for quantum tomography, Theory for Quantum Computation, Communication and Cryptography (TQC), Paris, France, Jun 2017.

Constructing optimal error regions for quantum state estimation, Central European Workshop for Quantum Optics, Brussels, Belgium, Jun 2014.

Optimal error regions, Institute of Physics Meeting, NUS, Singapore, Feb 2014.

Optimal error regions for quantum state estimation, Central European Workshop for Quantum Optics, Stockholm, Sweden, Jun 2013.

Quantum tomography with small number of copies: A minimax estimator for quantum states, APS March Meeting, Boston, USA, Mar 2012.

Towards a unified framework for approximate quantum error correction, APS March Meeting, Boston, USA, Mar 2012.

A simple approach to approximate quantum error correction, Quantum Information Processing, 13th Annual Workshop, Zurich, Switzerland, Jan 2010.

Approximately preserved information in quantum processes, 5th Canadian Quantum Information Students' Conference, Canada, Jul 2008.

The structure of preserved information in quantum processes, APS March Meeting, New Orleans, USA, Mar 2008.

Conference posters

Transport in 1D revisited: A simple, exact solution for phase disorder, Quantum Optics VIII conference, Jachranka, Poland, May 2013.

Combining dynamical decoupling with fault-tolerant quantum computation, Quantum Information Processing, 13th Annual Workshop, Zurich, Switzerland, Jan 2010.

Generalized entanglement as a unifying framework for fermionic entanglement, Quantum Information Processing, 12th Annual Workshop, Santa Fe, New Mexico, USA, Jan 2009.

Scientific publications

Published articles (24)

Y Zheng and HK Ng, *Digital quantum simulator in the presence of a bath*, Phys Rev A **96**, 042329 (2017).

MI Trappe, YL Len, HK Ng, and B-G Englert, *Airy-averaged gradient corrections for two-dimensional fermion gases*, Ann Phys **385**, 136 (2017).

B-G Englert, K Horia, J Dai, YL Len, and HK Ng, *Past of a quantum particle revisited*, Phys Rev A **96**, 022126 (2017).

J Shang, Z Zhang, and HK Ng, *Superfast maximum likelihood reconstruction for quantum tomography*, Phys Rev A **95**, 062338 (2017).

X Li, J Shang, HK Ng, and B-G Englert, *Optimal error intervals for properties of the quantum state*, Phys Rev A **94**, 062112 (2016).

J Dai, YL Len, and HK Ng, *Initial system-bath state via the maximum-entropy principle*, Phys Rev A **94**, 052112 (2016).

M-I Trappe, YL Len, HK Ng, C Mueller, and B-G Englert, *Leading gradient correction to the kinetic energy for two-dimensional fermion gases*, Phys Rev A **93**, 042510 (2016).

R Han, HK Ng, B-G Englert, *Implementing a neutral-atom controlled-phase gate with a single Rydberg pulse*, Europhys Lett **113**, 40001 (2016).

J Řeháček, Z Hradil, YS Teo, L Sánchez-Soto, HK Ng, JH Chai, and B-G Englert, *Least-bias state estimation with incomplete unbiased measurements*, Phys Rev A **92**, 052303 (2015).

Y-L Seah, J Shang, HK Ng, DJ Nott, and B-G Englert, *Monte Carlo sampling in the quantum state space. II*, New J Phys **17**, 043018 (2015).

J Shang, Y-L Seah, HK Ng, DJ Nott, and B-G Englert, *Monte Carlo sampling in the quantum state space. I*, New J Phys **17**, 043017 (2015).

V Paulisch, R Han, HK Ng, and B-G Englert, *Beyond adiabatic elimination: A hierarchy of approximations for multi-photon processes*, Eur Phys J Plus **129**, 12 (2014).

J Shang, HK Ng, A Sehrawat, X Li, and B-G Englert, *Optimal error regions for quantum state estimation*, New J Phys **15**, 123026 (2013).

HK Ng and B-G Englert, *One-dimensional transport revisited: A simple and exact solution for phase disorder*, Phys Rev B **88**, 054201 (2013).

R Han, HK Ng, and B-G Englert, *Raman transitions without adiabatic elimination: A simple and accurate treatment*, J Mod Opt **60**, 255 (2013).

HK Ng, KTB Phuah, and B-G Englert, *Minimax mean estimator for the trine*, New J Phys **14**, 085007 (2012). (Invited paper for Focus Issue on Quantum Tomography.)

P Mandayam and HK Ng, *Towards a Unified Framework for Approximate Quantum Error Correction*, Phys Rev A **86**, 012335 (2012).
HK Ng and B-G Englert, *A simple minimax estimator for quantum states*, Int J Quant Inf **11**, 1250038 (2012).
HK Ng, DA Lidar, and J Preskill, *Combining dynamical decoupling with fault-tolerant quantum computation*, Phys Rev A **84**, 012305 (2011).
R Blume-Kohout, HK Ng, D Poulin, and L Viola, *Information preserving structures: A general framework for quantum zero-error information*, Phys Rev A **82**, 062306 (2010).
HK Ng and P Mandayam, *Simple approach to approximate quantum error correction based on the transpose channel*, Phys Rev A **81**, 062342 (2010).
HK Ng and J Preskill, *Fault-tolerant quantum computation versus Gaussian noise*, Phys Rev A **79**, 032318 (2009).
R Blume-Kohout, HK Ng, D Poulin, and L Viola, *Characterizing the structure of preserved information in quantum processes*, Phys Rev Lett **100**, 030501 (2008).
B-G Englert, KM Tin, CG Goh, and HK Ng, *Single-Loop Interferometer for Minimal Ellipsometry*, Laser Phys **15**, 7 (2005).

Manuscripts in preparation (3)
JH Chai and HK Ng, *Fault-tolerance thresholds of surface codes versus concatenated codes*. (In preparation.)
YL Len and HK Ng, *Open system quantum error correction*. (In preparation.)
J Qi and HK Ng, *What does randomized benchmarking really measure?* (In preparation.)

arXiv-only manuscripts (comments or unpublished articles; 4)
J Shang, Y-L Seah, B Wang, HK Ng, DJ Nott, and B-G Englert, *Random samples of quantum states: Online resources*, arXiv:1612.05180 (2016). (Documentation for http://tinyurl.com/QSampling.)
J Shang, HK Ng, and B-G Englert, *Quantum state tomography: Mean squared error matters, bias does not*, arXiv:1405.5350 (2014). (Comment on Schwemmer et al. [arXiv:1310.8465].)
J Anders, HK Ng, B-G Englert, and SY Looi, *The Singapore Protocol: Incoherent Eavesdropping Attacks*, arXiv:quant-ph/0505069 (2005).
B-G Englert, D Kaszlikowski, HK Ng, WK Chua, J Řeháček, and J Anders, *Highly Efficient Quantum Key Distribution with Minimal State Tomography*, arXiv:quant-ph/0412075 (2004).

Book (1)
R Han and HK Ng (eds.), *Quantum Paths: Festschrift in Honor of Berge Englert on his 60th Birthday* (Book), World Scientific, Singapore (2015).

Research Grants (as Principal Investigator)
In progress
YNC Startup Grant (Jan 2014–Dec 2017), *Aspects of quantum information and quantum computation,* SGD$50,000.
MoE Tier-2 Grant (Feb 2017–Jan 2020), *Noise in quantum systems: Estimating relevant parameters*, SGD$431,200.

Completed
YNC Internal Grant (MoE Tier-1) (Feb 2015–Oct 2017), *Quantum Information Processing in non-Markovian noise from small baths*, SGD$179,640.

Teaching
Courses taught at Yale-NUS College
Scientific Inquiry 2 (YCC2137), AY2017/18 Sem 1 (on-going).
Classical Mechanics (YSC2203), AY2014/15 Sem2, AY2015/16 Sem2, AY2016/17 Sem2
Scientific Inquiry (YCC1131), AY2013/14 Sem1, 2014/15 Sem1, 2015/16 Sem1 (2 sections)
Quantum mechanics and quantum information, Independent study, AY2014/15 Sem1
Quantitative Reasoning (YCC1122), AY2013/14 Sem 2
Physics through Fermi Problems, Independent study, AY2013/14 Sem 2

Undergraduate research mentoring
Research mentor for students in the NUS UROPS programme, NUS Physics Honours-Year project students, CQT PhD students, postdocs at CQT, and YNC students, 2011–current.

Service

Academic and major advisor for undergraduate students in Yale-NUS, July 2013–current

Yale-NUS Faculty Committees
Science Common Curriculum Task Force, Mar 2016–Oct 2016
Committee for Faculty Affairs, Jan–May 2016
Curriculum Committee member, Aug–Dec 2014
Admissions Committee member, Aug 2013–Jul 2014

Yale-NUS Search Committees
Physical Science Search Committee member, Nov 2017- (ongoing)
Class of 2017 Graduation Speaker Search Committee member, Oct 2016–Apr 2017
Dean of Faculty Search Committee member, Aug2015–Dec 2015
Physical Science Search Committee member, Aug 2014–Feb 2015
Rector Search Committee member, Sep 2013–Jan 2014

Research conference organization
Schwinger Centennial (in celebration of 100 years of Julian Schwinger), NUS, 7-12 Feb 2018.
QuEST School (school on Quantum Engineering Science and Technologies), NUS, Jan 2018.
IPS 2017 (Institute of Physics Singapore Annual Meeting), YNC, 22-24Feb 2017.
QCMC 2016 (International conference on Quantum Communication, Measurement, and Computing), UTown, NUS, 4–8 July 2016.
BergeFest, conference in celebration of 60th birthday of Berge Englert, NUS, 22–26 April 2014
Mathematical Horizons for Quantum Physics II (workshop jointly organized by CQT and the Institute for Mathematical Sciences, NUS), 12 Aug–11 Oct 2013
Workshop on Quantum Tomography, CQT, NUS, 28 Nov–02 Dec 2011

Peer-review duties
Referee for Physical Review Letters, Physical Review X, Physical Review A, New Journal of Physics, Europhysics Letters (EPL), International Journal of Quantum Information, etc.

High-school outreach
Research@YDSP mentor (Young Defence Scientists Programme, for high-school student research internship), DSO National Laboratories, Singapore, 2009–2011, 2013.
Lecturer for the *World of Science: Quantum Mechanics* module (programme for high-school students), DSO National Laboratories, 2010–2011.
Judge for high-school science competitions
Singapore Science & Engineering Fair (SSEF) 2015-2017; International Young Physicists Tournament 2017; Singapore Young Physicists Tournament, 2012–2016; the Amazing Science-X Competition, Science Centre, 2014.

Research students and postdocs

Past students
On noise, quantum error correction (QEC) and fault tolerance (FT)
Undergraduate:
Wang Jiayun (2016), YNC Summer Science Research, *Noise from spin baths*
Abhinav Natarajan (2016), YNC Summer Science Research, *Sampling from the quantum state space*
Abhinav Natarajan (2015), YNC Student Associate, *Fault tolerance with stabilizer formalism*
Jake Goh Si Yuan (2015), YNC Student Associate, *Fault tolerance with stabilizer formalism*
Chia Pei Yun (2015), YNC Science Independent Research, *QEC in the presence of small baths*
Chan Li Ting (2014), YNC Summer Science Research, *Continuous-time QEC*
Wang Jiayun (2016-17), YNC Summer Science Research & Student Associate, *Two spins in a Magnetic Field*
Vanessa Koh (2017), YNC Summer Science Research, *On efficient entanglement generation*

Postdoc: Zheng Yicong (YNC, CQT)

On quantum state estimation (QSE) [co-mentored with B-G Englert (CQT, NUS)]:
Undergraduate:
Chai Jing Hao (2014), NUS Phys Honors Thesis, *Point estimators in QSE*
Max Seah Yi-Lin (2014), NUS Phys Honors Thesis, *Estimator regions in QSE*
Chai Jing Hao (2012), NUS UROPS, *Quantum state estimation with small samples*
Benjamin Phuah (2012), NUS UROPS, *Quantum state estimation with small samples*

Graduate PhD:
Dai Jibo (2015), *Experimental entanglement witness family measurement and theoretical aspects of quantum tomography*
Shang Jiangwei (2013), *Symmetric minimal quantum tomography and optimal error regions*
Li Xikun (2016), *Optimal error regions for QSE and state-property estimation*

Postdoctoral research fellow:
Shang Jiangwei (2013-2016)

On aspects of quantum theory and implementations [co-mentored with B-G Englert (CQT, NUS)]
Undergraduate:
Kelvin Horia (2014), NUS Phys Honors Thesis, *Post-selected data in quantum measurements*
Raditya Bomantara (2014), NUS Phys Honors Thesis, *Semiclassical trajectory dynamics*
Benjamin Phuah (2013), NUS Phys Honors Thesis, *How flipping spins delocalise---insights from a simple model*
Do Thi Xuan Hung, (2013), NUS Phys Honors Thesis, *Driven near-resonant two-photon and three-photon transitions*
Tan Wei Hou (2013), NUS Phys Honors Thesis, *Ionization of an atom by a passing-by charge*
Winson Tanputranam (2013), NUS UROPS, *Near-resonant two-photon transitions*

Graduate PhD:
Lu Yin (2012), *Light scattering by atoms with internal Zeeman degeneracy*
Han Rui (2012), *Robust quantum storage with three atoms*

Current students and postdocs
On noise, quantum error correction and fault tolerance
Undergraduate (student associates): Yonatan Aaron Gazit (YNC), Ivan Soh Wei Ern (YNC)
Graduate PhD: Len Yink Loong (CQT), Chai Jing Hao (CQT), Jiaan Qi (NUS Phys Dept)
Postdoctoral research fellow: Todd Lu Yiping (YNC, CQT)

On quantum state estimation [with B-G Englert (CQT, NUS) and DJ Nott (NUS Stat&AppProb]
Graduate PhD: Max Seah Yi-Lin (CQT), Sim Jun Yan (CQT)