

Nathan Shammah

Date of Birth: 12 April 1987
Place of Birth: Milan, Italy
Nationality: Italian

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Research Interests

My research focus is on open quantum systems dynamics, and the interplay between cooperative effects and dissipative mechanisms in many-body quantum systems, including quantum computing devices. I investigate how errors can be mitigated on noisy quantum computers. I have characterized novel light-matter physics phenomena for current devices, such as superconducting circuits and semiconductor quantum wells, for technology applications such quantum information processing and THz emission. I develop open-source software for quantum physics research and quantum technology. I used it to study noisy quantum information processing and light-matter interaction in solid-state cavity quantum electrodynamics (QED).

Analytical Techniques: Dissipative master equations and their symmetries, fermionic and bosonic many-body systems in second quantization, input-output theory, mean-field theories, continuous-variable quantum mechanics.

Numerical Techniques: Superoperator formalism, symmetric methods in Liouvillian space, development of open-source libraries in Python, such as Mitiq, PIQS, QuTiP.

Work Experience

- Mar 2020 – Now *Chief Technology Officer* – Unitary Fund *Berkeley, USA*
I lead the technical team performing in-house research projects and help support the open-source scientific ecosystem in quantum technology.
- May 2020 – Now *Visiting Scientist* – Theoretical Quantum Physics Lab, RIKEN *Wako-shi, Japan*
- Jan 2019 – Now *Visiting Scientist* – Applied Quantum Mechanics Group, Dept. Physics, Università degli Studi di Milano, *Milan, Italy*
- Aug 2016 – Mar 2020 *Postdoctoral Research Scientist* – Theoretical Quantum Physics Lab, RIKEN *Wako-shi, Japan*
- Jul 2017 – Mar 2020 *Co-founder* – Quantika, consulting hub quantika.co.

Education

- Apr 2013 – Jul 2016 **PhD in Physics** University of Southampton, School of Physics and Astronomy *UK*
Thesis: *Resonance Fluorescence and Superfluorescence of Intersubband Transitions*
- Apr 2010 – Mar 2012 **MSc in Physics (Laurea Magistrale). Final Grade: 110/110 cum laude**
Università degli Studi di Milano *Milan, Italy*
Thesis: *Quantifying the nonlinearity of a quantum oscillator*
- Dec 11 – Apr 12 *MSc Erasmus Placement Student*, Controlled Quantum Dynamics Group
Imperial College London *London, United Kingdom*
- Sep 10 – Apr 11 *MSc Erasmus Student* University of Copenhagen *Copenhagen, Denmark*
- Oct 2006 – Apr 2010 **BSc in Physics (Laurea Triennale)** Università degli Studi di Milano *Milan, Italy*
Thesis: *Diamagnetism and De Haas-van Alphen oscillations in the electronic gas*

Publications

8 published papers, 7 as first or last author, with a total of >200 citations, h-index: 6 ([Google Scholar](#), 3/2021).

Submitted or in preparation:

[11] *Exceptional point and cross-relaxation effect in a hybrid quantum system*

Zhen Chen, Guo-Qiang Zhang, Da Xu, Nathan Shammah, Shuai-Peng Wang, Meiyong Liao, Xin-You Lu, Tie-Fu Li, Yi-Pu Wang, Franco Nori, and J. Q. You (*Submitted to PRX Quantum*)

Preprints:

[10] *Symmetries and conserved quantities of boundary time crystals in generalized spin models*

Giulia Piccitto*, Matteo Wauters*, Franco Nori, and Nathan Shammah

<https://arxiv.org/abs/2101.05710> *equal contribution.

[9] *Mitiq: A software package for error mitigation on noisy quantum computers*

Ryan LaRose, Andrea Mari, Peter Karalekas, Nathan Shammah, and William J. Zeng

<https://arxiv.org/abs/2009.04417>

Peer-reviewed publications:

[8] *Mean-field validity in a dissipative critical system: Liouvillian gap, \mathbb{P} \mathbb{T} -symmetric antigap, and permutational symmetry in the XYZ model*

Dolf Huybrechts, Fabrizio Minganti, Franco Nori, Michiel Wouters, and Nathan Shammah

Phys. Rev. B **101**, 214302 (2020) [Link https://arxiv.org/abs/1912.07570](https://arxiv.org/abs/1912.07570)

[7] *Dissipation-induced bistability in the two-photon Dicke model*

Louis Garbe, Peregrine Wade, Fabrizio Minganti, Nathan Shammah, Simone Felicetti, and Franco Nori

Scientific Reports **10**, 13408 (2020) [Link https://arxiv.org/abs/1911.11694](https://arxiv.org/abs/1911.11694)

[6] *Multielectron Ground State Electroluminescence*

Mauro Cirio*, Nathan Shammah*, Neill Lambert, Simone De Liberato, and Franco Nori

Physical Review Letters, **122** 190403 (2019) [Link arXiv](#). *equal contribution.

[5] *Open quantum systems with local and collective incoherent processes: Efficient numerical simulation using permutational invariance*

Nathan Shammah, Shahnawaz Ahmed, Neill Lambert, Simone De Liberato, and Franco Nori

Physical Review A **98**, 063815 (2018) [Link arXiv](#)

[4] *Superradiance with local phase-breaking effects*

Nathan Shammah, Neill Lambert, Franco Nori, and Simone De Liberato

Physical Review A **96**, 023863 (2017) [Link arXiv](#)

[3] *Theory of intersubband resonance fluorescence*

Nathan Shammah and Simone De Liberato

Physical Review B **92**, 201402 Rapid Comm. (2015) [Link arXiv](#)

[2] *Terahertz emission from ac Stark-split asymmetric intersubband transitions*

Nathan Shammah, Chris C. Phillips, and Simone De Liberato

Physical Review B **89**, 235309 (2014) [Link arXiv](#)

[1] *Quantifying the nonlinearity of a quantum oscillator*

Matteo G.A. Paris, Marco G. Genoni, Nathan Shammah, and Berihu Teklu

Physical Review A **90**, 012104 (2014) [Link arXiv](#)

Terahertz emission from asymmetric, doped quantum wells under resonant pumping

Nathan Shammah, Chris C. Phillips, and Simone De Liberato

Journal of Physics: Conf. Series **619**, 012021 (2015). Peer-reviewed proceeding.

Open Source Libraries:

- [Mitiq](#): A Python toolkit for error mitigation on quantum computers.
- QuTiP, the Quantum Toolbox in Python, J. R. Johansson, P. Nation, A. Pitchford, N. Shammah, C. Granade, A. Grimsmo, S. Ahmed, Neill Lambert, E. Giguere, and F. Nori, <http://qutip.org>
- Permutational Invariant Quantum Solver (PIQS). Nathan Shammah and Shahnawaz Ahmed github.com/nathanshammah/piqs. Documentation: piqs.readthedocs.io
- *scikit-project*, <https://github.com/nathanshammah/scikit-project>
- Commits to: Qiskit, Cirq, PyEPR, Bokeh, Sphinx, Conda-Forge

Talks at International Meetings

- 2019 Dec 20th Invited talk at the 4th AQM Meeting *Milan, Italy*
- 2019 Sep 11th IQIS Conference *Milan, Italy*
- 2019 Sep 4th EuroScipy 2019 *Bilbao, Spain*
- 2019 Jan 26th Invited talk: RIKEN-Berkeley Quantum Information Science Workshop, *Berkeley, USA*
- 2018 Aug 31st EuroScipy 2018 – 11th European Conference on Python in Science *Trento, Italy*
- 2018 Jul 16th Current Trends in Open and Nonequilibrium Quantum Optical Systems, Max Planck Institute for the Science of Light *Erlangen, Germany*
- 2018 Jun 29th ImPACT JST Quantum Simulation Meeting *Wako-shi, Japan*
- 2018 Apr 18th C3QS – Coherent Control of Complex Quantum Systems, OIST *Okinawa, Japan*
- 2017 Feb 13th VSI Workshops – Quantum Steering and Time Correlations Workshop *Tokyo, Japan*
- 2015 Jul 12th PIERS Conference, Solid State Photonics Focus Session *Prague, Czech Republic*
- 2015 Mar 12th Advanced Polaritonics Workshop (the British Council funded my participation) *Suzdal, Russia*
- 2014 Jul 31st ICOOPMA14 – Intl. Conference on Optical, Optoelectronic and Photonic Materials *Leeds, UK*

Poster Presentations at International Meetings

- 2020 Dynamics, criticality, and universality in random quantum circuits [Workshop](#)
Max Planck Institute for the Physics of Complex Systems *Dresden, Germany*
- 2019 Coherent Network Computing Conference *Atsugi, Japan*
- 2018 JST Meeting on Quantum Computing (Cabinet of the Government of Japan)
- 2018 QFS 2018 – International Symposium on Quantum Fluids and Solids *Tokyo, Japan*
- 2018 C3QS – Coherent Control of Complex Quantum Systems, OIST *Okinawa, Japan*
- 2018 DAQS2018 – International Symposium on Dynamics in Artificial Quantum Systems *Tokyo, Japan*
- 2017 ISNTT 2017 – International School and Symposium on Nanoscale Transport and Photonics *Atsugi, Japan*
- 2017 QFML 2017 – Quantum Fluids of Light and Matter Conference *Cargèse, France*
- 2013 ISNP 2013 – International School of Nanophotonics and Photovoltaics *Maratea, Italy* **Best Poster Award**
- 2013 QUICC 2013 – International School on Quantum Information, Computing and Control *London, UK*
- 2013 International School of Photonics, Scuola Normale Superiore di Pisa e NEST *Cortona, Italy*

Talks at Research Centers

2020 Nov 26 th	Seminar, QSEM, University of Milan, <i>Milan, Italy</i>
2019 Sep 25 th	Seminar, Google Quantum A.I. Lab, Google. Host: Alan Ho. <i>Los Angeles, USA</i>
2019 Jul 1 st -5 th	6 Lectures on open quantum systems and open source, SISSA. Host: M. Dalmonte. <i>Trieste, Italy</i>
2019 Mar 25 th	Seminar, Univ. of Antwerp. Host: M. Wouters. <i>Antwerp, Belgium</i>
2019 Mar 21 st	Seminar, Vandersypen Lab, QuTech, TU Delft. Host: G. Zheng. <i>Delft, The Netherlands</i>
2019 Feb 1 st	IQIM Seminar, Caltech. Host: V. Albert. <i>Pasadena, USA</i>
2019 Jan 29 th	Seminar, Google Quantum A.I. Lab, Google. Host: H. Neven. <i>Los Angeles, USA</i>
2019 Jan 28 th	Seminar, NASA, Ames Research Center and USRA. Host: D. Venturelli. <i>Mountain View, USA</i>
2019 Jan 23 rd	Special Seminar, Appl. Physics Dept., Stanford University. Host: P. McMahon. <i>Palo Alto, USA</i>
2018 July 16 th	Seminar, Applied Quantum Mechanics Group, Univ. of Milan. Host: M. Genoni. <i>Milan, Italy</i>
2017 Aug 22 nd	Qulink – National Institute of Informatics. Host: K. Nemoto. <i>Tokyo, Japan</i>
2017 May 15 th	Laboratoire Pierre Aigrain – École Normale Supérieure Paris. Host: G. Hetet. <i>Paris, France</i>
2016 Oct 6 th	RIKEN Quantum Condensed Matter Research Group Meeting <i>Tokyo, Japan</i>
2015 Jun 3 rd	Bar-Ilan University. Host: E. Dalla Torre. <i>Tel Aviv, Israel</i>
2014 Jul 8 th	The Racah Institute of Physics, Hebrew Univ. of Jerusalem. Host: A. Retzker. <i>Jerusalem, Israel</i>
2014 Sep 19 th	Photonics Day, Zepler Institute and Optoelectronics Research Centre <i>Southampton, UK</i>
2012 Mar 21 st	QOLS Group, Imperial College London <i>London, UK</i>
2012 Nov 6 th	IQOQI. Host: A.V. Gorshkov. <i>Innsbruck, Austria</i>

Visits

Jul – Sep 2019	University of Milan Applied Quantum Mechanics Group. Host: Dr. Marco Genoni
Jun – Jul 2019	International School for Advanced Studies (SISSA) Trieste, Italy. Host: Dr. Marcello
Mar – Apr 2019	Dalmonte
Jul – Sep 2018	University of Antwerp <i>Antwerp, Belgium.</i> Host: Prof. M. Wouters
Jun – Jul 2015	University of Milan Applied Quantum Mechanics Group. Host: Dr. Marco Genoni RIKEN Wako-shi, Japan, Summer Research Intern, Quantum Condensed Matter Research Group

Workshop Organization

Feb 19-21 2019 **1st QuTiP Developers [Workshop](#) RIKEN, Wako, Japan.**

Awards

2016	University of Southampton Vice-Chancellor's Awards (Runner-up) Science Outreach
2015	Embassy of Italy in the UK 'Italy Made Me' Awards Certificate of Excellence in Research ^[SEP]
2013	Best Poster Award Awarded by the <i>EPL Journal</i> at the Intl. School of Nanophot. and Photovoltaics.

Funding

2013 – 2016	EPSRC UK and University of Southampton EPSRC DTA Studentship (PhD Funding)
2015	RIKEN Intern at the Quantum Condensed Matter Research Group ^[SEP]
2011 – 2012	European Union Placement at the Controlled Quantum Dynamics Group, Imperial College
2010 – 2011	European Union Erasmus Program at the Niels Bohr Institute, University of Copenhagen

Teaching and Mentoring

- 2018 – 2020 **Mentor** to two research interns, 4 PhD students, 2 MSc. students on my physics & code projects
 2019 – 2020 **Mentor** to Google Summer of Code students for the QuTiP project, NumFOCUS org.
 2017 – 2018 **Mentor** to Shahnawaz Ahmed, MSc student in Eng. and Physics, intern at RIKEN from BITS Pilani Goa, India
 2014 – 2015 **University of Southampton** *Southampton, United Kingdom*
Teaching Assistant, School of Physics and Astronomy
 Computational Techniques in Physics (PHYS 3008) and Atomic Physics (PHYS 6017)

Languages and IT Skills

Fluent: Italian (*Native*), English, French, Spanish. *Beginner*: Japanese.
 Programming: Python, C/C++, Mathematica, MATLAB. Libraries: QuTiP, Matplotlib, Cython, Scipy, Jupyter.

Service and Outreach

Referee for: *Nature Scientific Reports* (1), *Optics Communications* (1), *Eur. Phys. Journal Plus* (1), *Phys Lett A* (2), *SciPost Physics* (1), *IOP Quant. Sci. Tech.* (1), *PRX Quantum* (1)

2020 – 2021 Ecosystem Task Force Member, SQMS Collaboration, <http://sqms.fnal.gov/>

- 2017 July - Now Writer, Newsletter on Quantum Technology medium.com/quantum-tech.
 2019 Nov 7th Talk at Machine Learning Tokyo Meetup *Tokyo, Japan*
 2019 Oct 28th Article for the online newspaper Linkiesta.
 2019 Jan 11th Article: *The rise of open source in quantum physics research*, Nature Blogs – with S. Ahmed
 2018 Sep 29th Talk ‘Open-source for open science’, European Research Day, Italian Inst. of Culture *Tokyo*
 2017 Jun 16th Talk on Quantum Technologies at Nerd Nite Tokyo *Tokyo, Japan*
 2017 May 27th Talk at Falling Walls Lab, The National Museum of Emerging Science and Innovation *Tokyo*
 2017 Mar 10th Talk at the European Innovation Day by EURAXESS, Accenture Digital Hub *Tokyo, Japan*
 Aug 2014 – 2016 *University Coordinator*, Pint of Science International Festival *Southampton, United Kingdom*
 2016 May 16th Talk at the Researchers’ Café of the University of Southampton *Southampton, United Kingdom*
 2016 May 26th Article: *Que la lumière soit ! Mais une particule à la fois – The Conversation France*
 2013 May 15th Print and Online Article: *Five easy pieces on quantum information* – with S. De Liberato
IL magazine, Il Sole 24 Ore (the Italian business and finance newspaper)
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References

Prof. Franco Nori

Chief Scientist, RIKEN, Japan

Leader of the Theoretical Quantum Physics Laboratory, Cluster for Pioneering Research, <http://dml.riken.jp/>.

Also at the Physics Department, University of Michigan, Ann Arbor, MI 48109-1040, USA

E-mail: fnori@riken.jp

Prof. Simone De Liberato

Professor of Nanophotonics and Royal Society University Fellow, University of Southampton, UK.

Leader of the Quantum Theory and Technology Group, <http://simonedeliberato.org/>.

E-mail: S.De-Liberato@soton.ac.uk

Prof. Matteo G. A. Paris

Professor of Physics, Physics Department, University of Milan, Italy

Leader of the Applied Quantum Mechanics Group, <https://sites.unimi.it/aqm/>.

E-mail: matteo.paris@fisica.unimi.it