

# Paul D. Nation

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## Research Interests

Superconducting circuit devices, computational quantum physics, nanoelectromechanical systems (NEMS), analogue gravitational physics, quantum optics.

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## Education

- 2005-2010 **Ph.D. Physics**, *Dartmouth College*, Hanover, New Hampshire USA.  
Dissertation Topic: “[Quantum Dynamics of Nonlinear Cavity Systems](#)”  
Advisor: Miles P. Blencowe
- 2002-2005 **B.S. Physics**, *Utah State University*, Logan, Utah USA.  
Minor: Mathematics  
Graduated cum laude: 3.77/4.0

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## Honors and Awards

- 2014 **Outstanding Teaching Award**, (Computational Physics), Korea University.
- 2012 **Outstanding Teaching Award**, (Introductory Physics), Korea University.
- 2011-2012 **JSPS Foreign Postdoctoral Fellowship**, Japanese Society for the Promotion of Science.
- 2009-2010 **Graduate Assistance in Areas of National Need (GAANN) Fellowship**, U.S. Department of Education.
- 2009 **East Asia and Pacific Summer Institutes Fellowship**, NSF / JSPS.
- 2005-2006 **GAANN Fellowship**, U.S. Department of Education.
- 2005 **Best undergraduate science poster presentation**, Utah State University.

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## Grants

- 2013-2020 **Brain Korea 21<sup>+</sup> (BK21<sup>+</sup>) [KRW 2,746,737,000]**, “Initiative for Creative and Independent Scientists”, Korea University Department of Physics, Multiple Investigators.
- 2011-2012 **JSPS Grants-in-Aid (Kakenhi) [JPY 1,600,000]**, “Superconducting Circuits in Space Physics”, Single Investigator: PI Nation.
- 2011-2012 **JSPS [JPY 8,888,000]**, “Analogue Cosmology in Superconducting Circuits”, Single Investigator: PI Nation.
- 2009 **NSF [\$5,000]**, “Noise Properties of Nonlinear Quantum Amplifiers Near Bifurcations”, Single Investigator: PI Nation.

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## Academic Experience

- 2012-2015 **Assistant Professor**, *Korea University Department of Physics*, Seoul, South Korea.
- 2011-2012 **JSPS Foreign Postdoctoral Fellow**, *RIKEN Advanced Science Institute*, Wako-shi, Saitama Japan.
- 2010-2012 **Postdoctoral Research Associate**, *University of Michigan*, Ann-Arbor, Michigan USA.  
Department of Physics, based at RIKEN in Japan.

- 2010-2011 **Visiting Researcher**, *RIKEN Advanced Science Institute*, Wako-shi, Saitama Japan.  
Member of the Digital Materials Laboratory under Dr. Franco Nori.
- 2005-2010 **Graduate Student**, *Dartmouth College*, Hanover, New Hampshire USA.  
Includes Ph.D. research, Ph.D. and Masters level coursework and research projects. Guest lecturer for introductory quantum mechanics in summer 2008.
- 2009 **Visiting Researcher**, *NTT Basic Research Laboratories*, Atsugi, Kanagawa Japan.  
Worked with Dr. Hiroshi Yamaguchi, head of the Nanostructure Technology Research Group. Collaboration on using coupled oscillators to realize a purely mechanical ‘single-atom’ laser.

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## Publications, \* = co-first author

- **P. D. Nation**, J. Suh, and M. P. Blencowe, “Ultra-Strong Optomechanics Incorporating the Dynamical Casimir Effect”, [arXiv:1507.00115](#).
- **P. D. Nation**, “Steady-state solution methods for open quantum optical systems”, [arXiv:1504.06768](#).
- **P. D. Nation**, J. R. Johansson, M. P. Blencowe, and A. J. Rimberg, “Iterative solutions to the steady-state density matrix for optomechanical systems”, *Phys. Rev. E* **91**, 013307 (2015).
- A. J. Rimberg, M. P. Blencowe, A. D. Armour, and **P. D. Nation**, “A cavity-Cooper pair transistor scheme for investigating quantum optomechanics in the ultra-strong coupling regime”, *New J. Phys.* **16**, 055008 (2014).
- **P. D. Nation**, “Nonclassical mechanical states in an optomechanical micromaser analog”, *Phys. Rev. A* **88**, 053828 (2013).
- J. R. Johansson, **P. D. Nation\***, and F. Nori, “QuTiP 2: A Python framework for the dynamics of open quantum systems”, *Comp. Phys. Comm.* **184**, 1234 (2013).
- **P. D. Nation**, M. P. Blencowe, and F. Nori, “Non-equilibrium Landauer Transport Model for Hawking Radiation from a Black Hole”, *New J. Phys.* **14**, 033013 (2012).
- J. R. Johansson, **P. D. Nation\***, and F. Nori, “QuTiP: An open-source Python framework for the dynamics of open quantum systems”, *Comp. Phys. Comm.* **183**, 1760 (2012).
- **P. D. Nation**, J. R. Johansson, M. P. Blencowe, and F. Nori, “Stimulating uncertainty: Amplifying the quantum vacuum with superconducting circuits”, *Rev. Mod. Phys.* **84**, 1 (2012).
- **P. D. Nation** and M. P. Blencowe, “The trilinear Hamiltonian: a zero dimensional model of Hawking radiation from a quantized source”, Invited to focus issue on: “Classical and Quantum Analogues for Gravitational Phenomena and Related Effects”, *New. J. Phys.* **12**, 095013 (2010).
- **P. D. Nation**, M. P. Blencowe, A. J. Rimberg, and E. Buks, “Analogue Hawking Radiation in a dc-SQUID Array Transmission Line”, *Phys. Rev. Lett.* **103**, 087004 (2009).
- **P. D. Nation**, M. P. Blencowe, and E. Buks, “Quantum analysis of a nonlinear microwave-cavity embedded dc-SQUID displacement detector”, *Phys. Rev. B* **78**, 104516 (2008).
- **P. D. Nation**, A. Q. Howard, and L. J. Webb, “Modeling biological fluorescence emission spectra using Lorentz line shapes and nonlinear optimization”, *Appl. Opt.* **46**, 6192 (2007).

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## Conference Proceedings

- J. R. Johansson and **P. D. Nation**, “QuTiP: A framework for the dynamics of open quantum systems using SciPy and Cython”, *Proc. of the 11<sup>th</sup> Python in Science Conf.* (2012).

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## Conferences

- 2014 **co-Chair**, *Relativistic Quantum Information - North 2014*, Seoul, South Korea.

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## Computational Programs

- 2011-Present **QuTiP: The Quantum Toolbox in Python**, <http://qutip.org>.  
Open-source framework for solving the dynamics of open quantum systems. Includes Monte-Carlo and master equation algorithms, supporting arbitrary time-dependent Hamiltonians and Liouvillians. Supports multiprocessing and Cython based just-in-time (JIT) programming for compiled execution of time-dependent Hamiltonians. In collaboration with Dr. Robert J. Johansson.
- 2014 **SciPy**, <http://scipy.org>.  
Author of Reverse Cuthill-McKee and Maximum Bipartite Matching sparse matrix reordering algorithms in the `scipy.sparse.csgraph` module.

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## Publicity

- QuTiP: Quantum Toolbox in Python highlighted in “Programming: Pick up Python”, *Nature* **518**, 125 (2015).
- *Rev. Mod. Phys.* Colloquium: “Stimulating uncertainty: Amplifying the quantum vacuum with superconducting circuits” highlighted in *APS News*, Vol. 21, No. 2 (February 2012). <http://www.aps.org/publications/apsnews/201202/index.cfm>.
- “Quantum string links black holes and violins”, *Medill Reports*, Justin Eure (March 09, 2011). <http://news.medill.northwestern.edu/chicago/news.aspx?id=182459>.
- “Building Black Holes”, *Forbes*, Jonathan Fahey (October 27, 2009). <http://www.forbes.com/2009/10/27/physics-metamaterials-gravity-technology-breakthroughs-black-holes.html>.
- “Simulated Black Holes May Prove Hawking’s Theory”, *Discovery News*, Eric Bland (September 10, 2009). <http://news.discovery.com/tech/black-hole-simulation.html>.
- “An event on the horizon”, *Physics*, Jessica Thomas (August 17, 2009). <http://physics.aps.org/synopsis-for/10.1103/PhysRevLett.103.087004>.
- “Scientists Propose Lab-Grade Black Holes”, *ScienceNews*, Laura Sanders (August 13, 2009). [http://www.sciencenews.org/view/generic/id/46371/title/Scientists\\_propose\\_lab-grade\\_black\\_holes](http://www.sciencenews.org/view/generic/id/46371/title/Scientists_propose_lab-grade_black_holes).

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## Invited Conference / Workshop Talks

- “Quantum Vacuum Amplification”, 2014 “Open KIAS” School on Quantum Information Science, Seoul Korea, July 2014.
- “Circuit Quantum Electrodynamics: Quantum Optics on a Chip”, 3<sup>rd</sup> School of Mesoscopic Physics, Buyeo Korea, June 2014.
- “Nonclassical Mechanical States in an Optomechanical Micromaser Analogue”, Nonlinear Dynamics at the Nanoscale, Pohang Korea, August 2013.
- “The Superconducting Circuit Warm Up for Fundamental Physics”, 25<sup>th</sup> Workshop on Nanoscale and Mesoscopic Systems, Pohang Korea, November 2012.
- “Photon Production from the Quantum Vacuum”, 6<sup>th</sup> Winter School on Quantum Information Science, Huisun Taiwan, February 2012.
- “Hawking Radiation as a 1D Quantum Channel”, Quantum Science of Strongly Correlated Systems (QS<sup>2</sup>C) Theory Forum, RIKEN, Wako-shi Japan, September 2010.

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## Teaching Experience

- 2012-Present **Lecturer**, *Department of Physics*, Korea University.
- 2014-2015: PHYS-461: Computational Physics.
- 2013-2014: PHYS-506: Graduate Quantum Mechanics II.
- 2013-2015: PHYS-505: Graduate Quantum Mechanics.
- 2013: PHYS-721: Special Topics in Solid State Physics.
- 2013: PHYS-183: Physics for Life Scientists.
- 2012-2014: PHYS-152: Introductory Physics II.

- 2009-2010 **Member**, Department of Physics Graduate Committee, Dartmouth College.  
First graduate student to be on the graduate committee. Completely rewrote and reinstated the graduate student teaching evaluations that were put on hold in 2006.
- 2006-2009 **Teaching Assistant**, Department of Physics, Dartmouth College.  
Small group, hands on laboratory sessions, exam preparation guides, homework / laboratory evaluations, and open-door policy office hours for six undergraduate classes and graduate level quantum mechanics.
- 2008 **Guest Lecturer**, Introductory Quantum Mechanics, Dartmouth College.  
Lectures and visual demonstrations for undergraduate introductory quantum mechanics class (Griffith's level).
- 2005 **Teaching Assistant**, Department of Physics, Utah State University.  
Conducted laboratory sessions for introductory physics class.

## Public Outreach

- "Current Topics in Science: From Bananas to Zombies", Montessori School Tokyo, Tokyo Japan, January 2012.
- Judge for Science Fair International 2011, Columbia International School, Tokorozawa Japan, November 2011.
- "Why Choose a Career in Science?", Utsunomiya Girls High School, Utsunomiya Japan, September 2011.

## Non-Academic Experience

- 2004-2005 **Science Specialist**, *Dugway Proving Grounds, U.S. Army, Dugway, Utah USA*.  
Carried out work on modeling biological aerosol clouds and identification of constituent components. Specifically looked at using the fluorescence spectrum of aerosols for use in stand-off detection LIDAR systems.

## Journal Referee

- GRG, Nat. Commun., Nat. Phys., PRA, PRB, PRE, PRL, PRX, RMP