Curtis J. Broadbent, Ph.D. Curriculum Vitae

Contact Information

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Education

University of Rochester, Rochester, New York USA
Ph. D., Physics with Certificate of Teaching (October 2010)
Thesis: "Applications of High-Dimensional Photonic Entanglement"
Adviser: Dr. John C. Howell

Brigham Young University, Provo, Utah USA
B. S., Physics with Math minor (August 2003)
Thesis: "Energy and Loss in Dielectric-Field Systems"
Advisers: Dr. Justin Peatross and Dr. Scott Glasgow

Appointments

Assistant Professor Part-Time Univ. Rochester (07/2012-present)
Researcher and lecturer in theoretical and experimental quantum optics and quantum information.

Postdoctoral Research Associate Eberly Research Group - Univ. Rochester (2010-2012)
Researcher and lecturer in theoretical quantum optics and quantum information.

Summer Instructor Univ. Rochester (Summer 2009)
Taught the last two weeks of Mechanics for Pre-Medical Students.
Team-taught Electromagnetism and Modern Physics for Pre-Medical Students.

Graduate Research Assistant Howell Research Group - Univ. Rochester (2003-2010)
Researcher in experimental quantum optics and quantum information.

Refereed Publications

[15] "An Uncertainty Relation for Mutual Information,"
J. Schneeloch, C. J. Broadbent, and J. C. Howell, Phys. Rev. A **90**, 062119 (2014).

[14] “Improving Einstein-Podolsky-Rosen Steering Inequalities with State Information,” J. Schneeloch, C. J. Broadbent, and J. C. Howell, Phys. Lett. A **378**, 766 (2014).

[13] “Bell Violation with Discrete-Continuous Entanglement,” X.-F. Qian, C. J. Broadbent, and J. H. Eberly, New J. Phys. **16**, 013033 (2014).

[12] “Bounding the entanglement of *N* qubits with only four measurements,” S. M. Hashemi Rafsanjani, C. J. Broadbent, and J. H. Eberly, Phys. Rev. A **88**, 062331 (2013).

[11] “EPR Steering Inequalities from Entropic Uncertainty Relations,” J. Schneeloch, C. J. Broadbent, S. P. Walborn, E. G. Cavalcanti, and J. C. Howell, Phys. Rev. A **87**, 062103 (2013).

[10] “Null Values and Quantum State Discrimination,” O. Zilberberg, A. Romito, D. J. Starling, G. A. Howland, C. J. Broadbent, J. C. Howell, and Y. Gefen, Phys. Rev. Lett. **110**, 170405 (2013).

[9] “Violation of Continuous Variable Entanglement with Discrete Measurements,” J. Schneeloch, P. B. Dixon, G. A. Howland, C. J. Broadbent, and J. C. Howell, Phys. Rev. Lett. **110**, 130407 (2013).

[8] “Genuinely Multipartite Concurrence of *N*-qubit *X*-matricies,” S. M. Hashemi Rafsanjani, M. Huber, C. J. Broadbent, and J. H. Eberly, Phys. Rev. A **86**, 062303 (2012).

[7] “Solving non-Markovian open quantum systems with multi-channel reservoir coupling” C. J. Broadbent, J. Jing, T. Yu, and J. H. Eberly, Annals of Physics 327, 1962-1973 (2012).

[6] “Extracting an entanglement signature from only classical mutual information,” D. J. Starling, C. J. Broadbent and J. C. Howell, Phys. Rev. A **84**, 032305 (2011).

[5] “Experimental Violation of Two-Party Leggett-Garg Inequalities with Semi-weak Measurements,” J. Dressel, C. J. Broadbent, J. C. Howell and A. N. Jordan, Phys. Rev. Lett. **106**, 040402 (2011).

[4] "Discriminating Orthogonal Single-Photon Images," C. J. Broadbent, P. Zerom, H. Shin, J. C. Howell and R. W. Boyd, Phys. Rev. A **79**, 033802 (2009).

[3] "Preservation of Energy-Time Entanglement in a Slow Light Medium," C. J. Broadbent, R. M. Camacho, R. Xin and J. C. Howell, Phys. Rev. Lett. **100**, 133602 (2008).

[2] "Large-Alphabet Quantum Key Distribution Using Energy-Time Entangled Bipartite States," I. Ali-Khan, C. J. Broadbent and J. C. Howell, Phys. Rev. Lett. **98**, 060503 (2007).

[1] "All-Optical Delay of Images using Slow Light," R. M. Camacho, C. J. Broadbent, I. Ali-Khan and J. C. Howell, Phys. Rev. Lett. **98**, 043902 (2007). See the Washington Post article: http://www.washingtonpost.com/wp-dyn/content/article/2007/01/18/AR2007011801683.html.

Intellectual Property Publications

C. J. Broadbent and J. C. Howell, Invention Disclosure: "Real Space 3D Image and Video Generation System" (2014).

Honors and Awards

Outstanding Dissertation in the Natural Sciences at the University of Rochester (2011).
Editors' Suggestions demarcation - Phys. Rev. Lett. **98**, 043902 (2007).
Eagle Scout (1996).

Grants and Funding

$50,000 – Technology Development Fund, UR Ventures, University of Rochester (Dec. 2014).

Refereed Journals

European Physical Journal D
Entropy
Indian Journal of Physics
International Journal of Quantum Info.
Nature Communications
Nature Nanotechnology
Open Systems & Information Dynamics
Optics Express
Optics Letters
Physica A
Physical Review A
Physical Review Letters
Physical Review X
Quantum Information Processing

Professional Organizations

Optical Society of America (OSA)
American Physical Society (APS)
OSA Young Professional Program

Senior Collaborators

Robert W. Boyd	University of Rochester
Eric G. Cavalcanti	University of Sydney, Australia
Joseph H. Eberly	University of Rochester
Jim Franson	University of Maryland Baltimore County
John C. Howell	University of Rochester
Andrew N. Jordan	University of Rochester
Todd Pittman	University of Maryland Baltimore County

Stephen P. Walborn	Universidade Federal do Rio De Janeiro, Brazil
Ting Yu	Stevens Institute of Technology

Committees and Professional Activities

Guest Editor, Feature Issue of the Journal of the Optical Society of America B: “80 years of Steering and the Einstein, Podolsky, Rosen Paradox”, to be published in 2015.

Referee for Air Force Young Investigator Program, Nov. 2014.

Session Presider, Quantum Communication and Quantum Computing with Photons III, Advances in Photonics of Quantum Computing, Memory, and Communication VII, Photonics West, San Francisco CA (Feb. 2014).

Session Presider, Tutorial and Slow and Fast Light in Vapor, Advances in Slow and Fast Light VII, Photonics West, San Francisco CA (Feb. 2014).

Session Presider, Photonic Crystal Interfaces, Frontiers in Optics 2013/Laser Science XXIX, Orlando FL, (Oct. 2013).

Session Presider, Biomedical Imaging, Frontiers in Optics 2011/Laser Science XXVII, San Jose CA, (Oct. 2011).

Guest Lecturer, Pre-College Experience in Physics for high-school girls, University of Rochester, Rochester NY, (July 2012).

OSA Student Chapter and Local Section Excellence Awards Committee Member, Optical Society of America (Sept. 2011).

Organizing Committee Co-Chair, Cross Border Workshop in Laser Science, Rochester NY, (June 9-11, 2011).

Talks and Presentations

[35] “Uncertainty, Mutual Information, and the Quantum One-Time Pad,” **C. J. Broadbent**, Department Colloquium, University of Rochester Department of Physics and Astronomy, Rochester, NY (Nov. 2014).

[34] “High-dimensional entanglement characterization via compressive sensing,” **C. J. Broadbent** on behalf of J. C. Howell, D. Lum, and Greg. A. Howland, Photonics West, San Francisco, CA (Feb. 2014).

[33] “Dispersion Amplification,” **C. J. Broadbent** on behalf of J. C. Howell, Photonics West, San Francisco, CA (Feb. 2014).

[32] “Revealing quantum steering using entropy: The EPR paradox meets information theory,” **C. J. Broadbent**, Quantum Optics Seminar, University of Toronto, Ontario, Canada (Oct. 2013).

[31] “Entropic EPR Steering Inequalities,” **C. J. Broadbent**, J. Schneeloch, S. P. Walborn, E. G. Cavalcanti, and J. C. Howell, Frontier in Optics/Laser Science 2013, Orlando, FL (Oct. 2013).

[30] “Witnessing Continuous Variable Einstein-Podolsky-Rosen Steering with Discrete Measurements,” **J. Schneeloch**, P. B. Dixon, C. J. Broadbent, G. A. Howland, and J. C. Howell, Frontiers in Optics/Laser Science 2013, Orlando, FL (Oct. 2013).

[29] “Einstein-Podolsky-Rosen Steering Inequalities from Entropic Uncertainty Relations”, **J. Schneeloch**, C. J. Broadbent, S. P. Walborn, E. G. Cavalcanti, and J. C. Howell, Conference on Quantum Information and Quantum Control, Toronto, Ontario, Canada (August 2013).

[28] “Violation of Continuous Variable EPR Steering with Discrete Measurements,” **J. Schneeloch**, P. B. Dixon, G. A. Howland, C. J. Broadbent, and J. C. Howell, CLEO: QELS Fundamental Science, San Jose, CA (June 2013).

[27] “Single Photon Slow Light: Quantum Optics at a Snail's Pace,” **C. J. Broadbent**, Photons after Dark Talk Series, Rochester Institute of Technology, Henrietta, NY (Mar. 2013).

[26] “Testing separability of mixed states by reducing them to X-matricies,” **S. M. Hashemi Rafsanjani**, S. Agarwal, and C. J. Broadbent, Poster, Cross Border Workshop in Laser Science XIV, McGill University, Montréal, Canada (June 2012).

[25] “Quantum Optics Theory and Computation,” **J. H. Eberly**, **C. J. Broadbent**, and **X. Wang**, Center for Integrated Research Computing Symposium, University of Rochester, Rochester NY (Dec. 2011).

[24] “Probabilistic evasion of environment induced decoherence,” **C. J. Broadbent**, Department of Mathematics Colloquium, Brigham Young University, Provo UT (Nov. 29, 2011).

[23] “Reduced decoherence in Non-Markovian systems lacking decoherence free subspaces,” **C. J. Broadbent**, J. Jing, T. Yu, and J. H. Eberly, Frontiers in Optics 2011/Laser Science XXVII, San Jose CA (Oct. 2011).

[22] “Managing Decoherence (when it cannot be avoided),” **C. J. Broadbent**, J. Jing, T. Yu, and J. H. Eberly, University at Buffalo Workshop in Quantum Computing, Buffalo NY (Sept. 2011).

[21] “Explorations into quantum state diffusion beyond the Markov approximation,” Poster, **C. J. Broadbent**, J. Jing, T. Yu, and J. H. Eberly, 42nd Annual Meeting of the APS Division of Atomic, Molecular and Optical Physics, Atlanta GA (June 2011).

[20] “Extracting an entanglement signature from only classical mutual information,” **D. J. Starling,** C. J. Broadbent*, and J. C. Howell, Poster, Cross Border Workshop in Laser Science XIII, Rochester NY (June 2011). *Author added after abstract submission.

[19] “Extracting an entanglement signature from only classical mutual information,” **D. J. Starling,** C. J. Broadbent*, and J. C. Howell, Conference on Lasers and Electro-Optics, Baltimore MD (May 2011). *Author added after abstract submission.

[18] “Experimental Violation of a Non-local Leggett-Garg Inequality Using Non-local Weak Measurements,” C. J. Broadbent, **J. Dressel**, A. N. Jordan and J. C. Howell, Frontiers in Optics 2010, Rochester NY (Oct. 2010).

[18] “A Weak Value Inequality as a Test for Local Realism,” J. Dressel, **C. J. Broadbent**, and A. N. Jordan, Conference on Lasers and Electro-Optics/Quantum Electronics and Laser Science, San Jose CA (May 2010).

[17] “Slow and Stopped Images,” P. V. Vudya Setu, D. Starling, R. M. Camacho, C. J. Broadbent, and **J. C. Howell**, Slow and Fast Light, Honolulu HI (July 2009).

[16] "Single Photon Image Discrimination," **C. J. Broadbent**, J. C. Howell, H. Shin, P. Zerom, and R. W. Boyd, International Conference on Quantum Information, Boston MA (July 2008).

[15] "Slow Light with Fourth Order Fields," **C. J. Broadbent**, P. K. Vudyasetu, R. M. Camacho, R. Xin, and J. C. Howell, Slow and Fast Light, Boston MA (May 2008).

[14] "Preservation of Entanglement in a Slow Light Medium," **C. J. Broadbent**, R. M. Camacho, R. Xin, and J. C. Howell, Conference on Lasers and Electro-Optics/Quantum Electronics and Laser Science, San Jose CA (May 2008).

[13] “All Optical Delay of Images Using Slow Light,” **R. Camacho**, C. Broadbent, I. Ali-Khan, and J. Howell, Slow and Fast Light/International Conference on Quantum Information, Salt Lake City UT (June 2007).

[12] “Implementations of Double-Resonance Slow Light,” **R. M. Camacho**, M. V. Pack, C. J. Broadbent, I. Ali-Khan, and J. C. Howell, Frontiers in Optics, San Jose CA (Oct. 2007).

[11] "Large Alphabet Quantum Key Distribution," Poster, J. C. Howell, I. Ali Khan and **C. J. Broadbent**, Frontiers in Optics/Laser Science XXII, Rochester NY (Oct. 2006).

[10] "Theoretical and Practical Limits of Large Alphabet Energy-Time Quantum Key Distribution," **C. J. Broadbent**, Ali Khan, A. Toulouse, P. A. Lopata, T. B. Bahder, J. C. Howell, Frontiers in Optics/Laser Science XXII, Rochester NY (Oct. 2006).

[9] "Large Dimensional Energy Time Quantum Key Distribution," **C.J. Broadbent**, I. Ali Khan and J. C. Howell, Poster, ARO/DTO Joint QIST Conference & Program Review, San Antonio TX (June 2006).

[8] "Experimental Demonstration of Large Alphabet Quantum Key Distribution using Energy Time Entanglement," **I. Ali Khan**, C. Broadbent, J. C. Howell, Conference on Lasers and Electro-Optics/Quantum Electronics and Laser Science Post-deadline Paper, Long Beach, CA (May 21-26, 2006).

[7] "Experimental Demonstration of Entanglement Reduction and Restoration for Three Party Secret Sharing," **C. J. Broadbent**, I. Ali Khan and J. C. Howell, Conference on Lasers and Electro-Optics/Quantum Electronics and Laser Science, Long Beach CA (May 2006).

[6] "Energy transport in dispersive media," **S. A. Glasgow**, J. Peatross, M. Ware, and C. Broadbent, Frontiers in Optics, Rochester NY (Oct. 2004).

[5] "Separation of mechanical and heat energy in an absorbing medium," **C. Broadbent**, M. Clayton, S.A. Glasgow, G. Hovhannisyan, J. Peatross, OSA Annual Meeting/Laser Science XVII, Orlando FL (Oct. 2002).

[4] "Separation of free energy and loss in absorbing media," **C. Broadbent**, J. Peatross, M. Meilstrup, G. Hovhannisyan, S. Glasgow, M. Clayton, APS Four Corners Meeting, Salt Lake City UT (Oct. 2002).

[3] "Optimal Energy Recovery in Linear Absorbing Media," **M. Meilstrup**, G. Hovhannisyan, S. Glasgow, C. Broadbent, J. Peatross, M. Clayton, APS Four Corners Section Meeting, Salt Lake City UT (Oct. 2002).

[2] "Reversible and Irreversible Processes in Dispersive/Dissipative Media: Electro-Magnetic Free Energy and Heat Production," **S. Glasgow**, J. Peatross, C. Broadbent, M. Clayton, Kavli Institute for Theoretical Physics, Miniprogram on Quantum Optics, Santa Barbara, CA, (July 2002). http://online.itp.ucsb.edu/online/qo02/glasgow/.

[1] "Free Energy & Heat in Linear Dielectrics: Homographic Transformations of the Plane, Continued Fractions, Quadratic Forms and Lyapunov Functions," **S. A Glasgow**, G. Hovhannisyan, M. Clayton, J. Peatross, C. Broadbent, B. Webb, University of Arizona's Complex Systems Seminar, Dept. of Physics (Oct. 2001)**.**

Book Chapters

"Dynamical Energy and Loss in Dispersive/Dissipative Dielectrics," C. Broadbent,

G. Hovhannisyan, J. Peatross, M. Clayton and S. Glasgow in *Focus on Lasers and Electro-Optics Research,* ed. W. T. Arkin, 253-261 (Nova Science Publishers, 2004).

Non-refereed publications

"Real-time determination of free energy and losses in optical absorbing media,"
C. Broadbent, G. Hovhannisyan, J. Peatross, M. Clayton, S. Glasgow,"
arXiv:physics/0207117v1 (2002).

"Reversible and Irreversible Processes in Dispersive/Dissipative Media: Electro-Magnetic Free Energy and Heat Production," C. Broadbent, G. Hovhannisyan, M. Clayton, J. Peatross, and S. A. Glasgow, in *Ultra-Wideband Short-Pulse Electromagnetics 6*, eds. E. L. Mokole, M. Kragalott, and K. Gerlach, 131-142 (Plenum Publishers 2002).