JEFF LUNDEEN

CURRICULUM VITAE

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WORK AND EDUCATION

Assistant Professor – Physics, University of Ottawa (2013–Present), Adjunct (2012-13)
Leading a research team in experimental quantum optics, quantum metrology, and quantum information with the goal of developing novel quantum-based technologies.

Associate Research Officer, National Research Council, (2013–2013), Research Associate (2009-2011), Assistant Research Officer (2011-2013)
Investigated photon sources (quantum dots, downconversion) and quantum metrology to develop radiometric standards. Performed the first direct measurement of the quantum wavefunction.

Postdoctoral Fellow, Oxford University (2006–2008) with Prof. Ian Walmsley.
Designed, built and characterized entangled photon pair sources based on photon-pair generation in nonlinear crystals and photonic crystal fibers (the first production of pure-state single photons); implemented the first "detector tomography"; supervised five summer students, two undergraduates, six graduate students, and three post-doctoral researchers.

Ph.D. – Physics, University of Toronto (2006) with Prof. Aephraim Steinberg.
Thesis: Measurement in post-selected systems in quantum optics and information

Experiments with spontaneous parametric down-conversion for the investigation of single-photon-level nonlinear optics and generalized measurement in quantum optics and quantum information and quantum metrology.

M.Sc. – Physics, University of Toronto (2000) with Prof. Aephraim Steinberg.
Thesis: 100% reflection in less than no time at all.

A measurement of the reflection time, predicted to be negative, from a Gire-Tournois interferometer.

B.Sc. Honours – Physics, Queen's University, Canada (1999).
Thesis: Experimental interaction-free measurement.

A demonstration of interaction-free measurement with a weak coherent state.

SIGNIFICANT CONTRIBUTIONS

- The first direct measurement of the quantum wavefunction
- The first tomographic mapping of a detector's operation
- The first generation of single photons in a well-defined spectral-temporal mode
- Pioneering quantum enhanced interferometry with constructed multi-photon states
- Development of techniques for probing sensitive quantum systems

AWARDS AND HONOURS

- Talk chosen as best of CORM 2012
- Research chosen as 2nd most important physics breakthrough of 2011 by Physics World.
- INMS Young Investigator Award for "research in quantum metrology" (2011)
- INMS Peer Award for "pioneering work in metrology" (2010)
- NSERC Post-doctoral Fellowship (Canada-wide) $90,000 (2006-2008)
- University of Toronto Open Fellowship $17,000 (2004)
- Walter C. Sumner Fellowship $12,000 (2002, 2003)
- Van Kranendonk Teaching Award Physics Dept., University of Toronto (2003)
- NSERC PGSB (Canada-wide Ph.D. scholarship) $42,000 (2001)
- NSERC PGSA (Canada-wide M.Sc. scholarship) $36,400 (1999)
- Ontario Graduate Scholarship $14,000 (1999)
- Harold M. Cave Experimental Physics Award (1997)
- Trillium Entrance Scholarship $1000 (1995)

PUBLICATIONS

Thirty-nine publications in refereed journals and books (2 Nature, 1 Nature Physics, 1 Nature Photonics, 11 PRL) and one patent.

1. **Observing Dirac's Classical Phase Space Analog to the Quantum State**
   Charles Bamber, Jeff S. Lundeen
   Physical Review Letters, **112**, 070405 (2014).

2. **Mapping coherence in measurement via full quantum tomography of a hybrid optical detector**
   Lijian Zhang, Hendrik Coldenstrodt-Ronge, Animesh Datta, Graciana Puentes, Jeff S. Lundeen, Xian-Min Jin, Brian J. Smith, Martin B. Plenio, and Ian A. Walmsley
   Nature Photonics 6, 364-368 (2012).

3. **Procedure for direct measurement of the general quantum states using weak measurement**
   Jeff S. Lundeen and Charles Bamber
   Physical Review Letters, **108**, 070402 (2012).

4. **Measurement of the transverse electric field profile of light by a self-referencing method with direct phase determination**
   C. Bamber, B. Sutherland, A. Patel, C. Stewart, and J. S. Lundeen
   Optics Express, **20**, 2034 (2012).

5. **Nonlinearity in single photon detection: modeling and quantum tomography**
   Mohsen K. Akhlaghi, A. Hamed Majedi, and Jeff S. Lundeen
   Optics Express **19**, 21305 (2011).

6. **Direct measurement of the quantum wavefunction**
   Jeff S. Lundeen, Brandon Sutherland, Aabid Patel, Corey Stewart, and Charles Bamber
   Nature, **474**, 188 (2011).

7. **Optimal experiment design for quantum state tomography: Fair, precise, and minimal tomography**
   J. Nunn, B. J. Smith, G. Puentes, I. A. Walmsley, and J.S. Lundeen
   Physical Review A, **81**, 042109 (2010).

8. **Photon pair generation in birefringent optical fibers,**
   Brian J. Smith, P. Mahou, Offir Cohen, J. S. Lundeen, I. A. Walmsley
   Optics Express, **17**, 23589 (2009).

9. **Quantum phase estimation with lossy interferometers**
   R. Demkowicz-Dobrzanski, U. Dorner, B. J. Smith, J. S. Lundeen, W. Wasilewski, K. Banaszek, and I. A. Walmsley
   Physical Review A, **80**, 013825 (2009).

10. **Measuring measurement: theory and practice**
    A. Feito, J.S. Lundeen, H. Coldenstrodt-Ronge, J. Eisert, M.B. Plenio and I.A. Walmsley
    New Journal of Physics, **11,** 093038 (2009).

11. **The characterization of the single-photon sensitivity of a Electron Multiplying Charge Coupled Device**
    L. Zhang, L. Neves, J.S. Lundeen, and I.A. Walmsley
    Journal of Physics B: Atmospheric, Molecular and Optical Phyics, **42,** 114011 (2009).

12. **Experimental joint weak measurement on a photon pair as a probe of Hardy's Paradox**
    J.S. Lundeen and A.M. Steinberg
    Physical Review Letters, **102**, 020404 (2009).

13. **Direct efficiency-calibration of a photon number resolving detector**
    A. Worsley, H. B. Colderstrodt-Ronge, J. S. Lundeen, P. J. Mosley, and I. A. Walmsley
    Optics Express, **17**, 4397 (2009).
    UK patent application (Ref: 3960/rr).

14. **Tailored photon-pair generation in optical fibers**
    O. Cohen, J.S. Lundeen, P.J. Mosley, B.J. Smith, G. Puentes, and I. A. Walmsley
    Physical Review Letters, **102**, 123603 (2009).

15. **Bridging wave and particle sensitivity in a single POVM configurable detector**
G. Puentes, J. S. Lundeen, M. P. A. Branderhorst, B. J. Smith, H. B. Colderstrodt-Ronge, and I. A. Walmsley
Physical Review Letters, **102**, 080404 (2009).

16. **Optimal Quantum Phase Estimation**
U. Dorner, R. Demkowicz-Dobrzanski, B.J. Smith, J.S. Lundeen, W. Wasilewski, K. Banaszek, and I. A. Walmsley
Physical Review Letters, **102**, 040403 (2009).

17. **Tomography of quantum detectors**
J.S. Lundeen, A. Feito, H. Coldenstrodt-Ronge, K.L. Pregnell, Ch. Silberhorn, T.C. Ralph, J. Eisert, M.B. Plenio, and I.A. Walmsley
Nature Physics, **5**, 27 - 30 (2009).

18. **Conditional preparation of single photons using parametric downconversion: a recipe for purity**
P. J. Mosley, J. S. Lundeen, B. J. Smith, P. Wasylczyk, A. B. U'Ren, C. Silberhorn, I. A. Walmsley
New Journal of Physics, **10**, 093011 (2008).

19. **Focusing on factorability: space-time coupling in the generation of pure heralded single photons**
P. J. Mosley, J. S. Lundeen, B. J. Smith, I. A. Walmsley
Journal of Modern Optics, **56**, 179 (2009).

20. **A proposed testbed for detector tomography**
H. B. Coldenstrodt-Ronge, J. S. Lundeen, K. L. Pregnell, A. Feito, B. J. Smith, W. Mauerer, C. Silberhorn, J. Eisert, M. B. Plenio, I. A. Walmsley
Journal of Modern Optics, **56**, 432 (2009).

21. **Heralded generation of ultrafast single photons in pure quantum states**
P. J. Mosley, J. S. Lundeen, B. J. Smith, P. Wasylczyk, A. B. U'Ren, C. Silberhorn, I. A. Walmsley
Physical Review Letters **100**, 133601 (2008).

22. **A short perspective on long crystals: broadband wave mixing and its application to ultrafast quantum optics**
P. Wasylczyk, A. B. U'Ren, P. Mosley, J. Lundeen, M. P. A. Branderhorst, S.-P. Gorza, A. Monmayrant, A. Radunsky and I. A. Walmsley
Journal of Modern Optics, **54**, 1939 (2007).

23. **Photon pair-state preparation with tailored spectral properties by spontaneous four-wave mixing in photonic-crystal fiber**
K. Garay-Palmett, H. J. McGuinness, Offir Cohen, J. S. Lundeen, R. Rangel-Rojo, M. G. Raymer, C. J. McKinstrie, S. Radic, A. B. U'Ren and I. A.Walmsley
Optics Express **15**, 14870 (2007).

24. **Classical dispersion-cancellation interferometry**
K. J. Resch, P. Puvanathasan, J. S. Lundeen, M. W. Mitchell, K. Bizheva
Optics Express **15**, 8797 (2007).

25. **A double-slit 'which-way' experiment addressing the complementarity-uncertainty debate**
R. Mir, J.S. Lundeen, M.W. Mitchell, A.M. Steinberg, H. M. Wiseman, and J. L. Garretson
New Journal of Physics **9**, 287 (2007).

26. **Comment on "Linear optics implementation of weak values in Hardy's paradox"**
J.S. Lundeen, K.J. Resch, and A.M. Steinberg
Physical Review A **72**, 016101 (2005).

27. **Practical measurement of joint weak values and their connection to the annihilation operator**
J.S. Lundeen and K.J. Resch
Physics Letters A **334**, 337 (2005).

28. **Super-resolving phase measurements with a multi-photon entangled state**
M.W. Mitchell, J.S. Lundeen, and A.M. Steinberg
Nature **429**, 161 (2004).

29. **Photon-exchange effects on photon-pair transmission**
K.J. Resch, G.G. Lapaire, J.S. Lundeen, J.E. Sipe, A.M. Steinberg
Physical Review A **69**, 063814 (2004).

30. **Experimental realization of the quantum box problem**
K.J. Resch, J.S. Lundeen, A.M. Steinberg
Physics Letters A **324**, 125 (2004).

31. **Experimental application of decoherence-free subspaces in a optical quantum computing algorithm**
M. Mohseni, J.S. Lundeen, K.J. Resch, and A.M. Steinberg
Physical Review Letters **91**, 187903 (2003)

32. **Practical creation and detection of polarization Bell states using parametric down-conversion**
K.J. Resch, J.S. Lundeen, and A.M. Steinberg
The Physics of Communication, Antoniou, Sadovnichy, and Walther eds., World Scientific, pp 437-451 (2003).

33. **Conditional-phase switch at the single-photon level**
K.J. Resch, J.S. Lundeen, and A.M. Steinberg
Physical Review Letters, **89**, 037904 (2002).

34. **Quantum state preparation and conditional coherence**
K.J. Resch, J.S. Lundeen, and A.M. Steinberg
Physical Review Letters, **88**, 113601 (2002).

35. **Electromagnetically induced opacity for photon pairs**
    K.J. Resch, J.S. Lundeen, and A.M. Steinberg
    Journal of Modern Optics, **49**, 487 (2002).

36. **Nonlinear optics with less than one photon**
    K.J. Resch, J.S. Lundeen, and A.M. Steinberg
    Physical Review Letters, **87**, 123603 (2001).

37. **Total reflection cannot occur with a negative time delay**
    K.J. Resch, J.S. Lundeen, A.M. Steinberg
    IEEE Journal of Quantum Electronics, **37**, 794 (2001).

38. **Comment on "Manipulating the frequency-entangled states by an acoustic-optical modulator"**
    K. J. Resch, S.H. Myrskog, J.S. Lundeen, and A. M. Steinberg
    Physical Review A, **64**, 056101 (2001).

39. **Experimental observation of nonclassical effects on single-photon detection rates**
    K.J. Resch, J.S. Lundeen, and A.M. Steinberg
    Physical Review A, **63**, 020102(R) (2001).

TALKS AND PRESENTATIONS

Thirty-three presentations.

1. **Seeing is Believing: Direct Observation of the Wavefunction**
   Canadian Association of Physicists Undergraduate Lecture Tour, McGill, U. of Northern British Columbia, U. of British Columbia, U. of Victoria, Ottawa, U. of Guelph (2014).

2. **The search for Fock: Generating, manipulating, and detecting single photons**
   Invited Talk, Physics Dept., Carleton (2013).

3. **Quantum Radiometry at NRC**
   Council for Optical Radiation Measurements, Ottawa (2012).

4. **Seeing is Believing: Direct Observation of the Wavefunction**
   Invited Talk, Physics Dept., Queen's University (2012).

5. **Seeing is Believing: Direct Observation of the Wavefunction**
   Invited Talk, MIT, Boston (2012).

6. **Quantum Metrology with Light**
   Invited Talk, Frontiers in Optics, San Jose (2011).

7. **Single Photons, from Generation to Detection**
   Invited Talk, Physics Dept., University of Ottawa (2011).

8. **Ideal Fock states and detectors**
   Invited Talk, Physics Dept., University of Delaware (2011).

9. **Characterization of Single-Photon States of Light**
   Invited Talk, Cross-Border Workshop on Laser Science, Waterloo (2010).

10. **Observation of the Quantum Wavefunction**
    Invited Talk, Physics Dept., University of Toronto (2010).

11. **The Search for Fock**
    Invited talk, Physics Dept., University of Waterloo (2010).

12. **Production and Characterization of Single-Photon States of Light**
    Invited talk, Cross-Border Workshop on Laser Science, Waterloo (2010).

13. **Bridging Particle and Wave Responsivity in a Phase-Sensitive Photon-Number Detector**
    Oral presentation, Single Photon Workshop, Boulder, Colorado (2009) – refereed.

14. **Photon Pair Generation in Birefringent Fiber: A Route to Better Photons**
    Invited talk, Frontiers in Optics, San Jose (2009) – refereed.

15. **Designed photons from birefrigent waveguides**
    Oral presentation, Conference on Quantum Information and Quantum Control III, Toronto (2009) – refereed.

16. **The search for the perfect photon**
    Invited talk, Institute for Quantum Computing, University of Waterloo (2009).

17. **Quantum Metrology with light**
    Invited talk, National Research Council, Institute for National Measurement Standards, Ottawa (2008).

18. **The generation of uncorrelated photon-pairs in an optical fibre**
    Oral presentation, *CLEO/QELS,* San Jose (2008) – refereed.

19. **Measuring Measurement**
    Poster, Solvay Conference, Brussels (2008) – refereed.

20. **The search for the perfect photon**
    Invited talks, Bristol University (2008), ICFO Barcelona (2008).

21. **Photon generation and storage**
    Invited talk, Imperial-Oxford-Cambridge Quantum Coherence Meeting, London (2007).

22. **Pure photons for continuous variables**
    Invited talk, *Continuous Variable QIP Conference*, St. Andrews (2007).

23. **Exploring quantum measurement in photonic systems**.
    Invited talks, University of Oxford, Oxford; Max Planck Institute for Quantum Optics, Munich; and Niels Bohr Institute, Copenhagen (2005).

24. **Experimental Weak Measurements in Hardy's Paradox**
    Oral presentation, *CLEO/QELS*, Baltimore (2005) – refereed.

25. **Applications of a nonlinear photon switch to Hardy's Paradox and Bell-state determination**
    Invited talk, *Physics of Quantum Electronics*, Snowbird, Utah (2005).

26. **Tailored quantum error-correction: Experimental effort**
    Poster, *DARPA Quantum Information Science and Technology*, Ft. Lauderdale (2003).

27. **Playing games with quantum Information: Experiments with photons and laser-cooled atoms**
    Invited talk, *Canadian Association of Physicists Annual Meeting*, Charlottetown (2003).

28. **An Experimental Implementation of Hardy's Paradox**
    Oral presentation, *CLEO/QELS*, Baltimore (2003) – refereed.

29. **A Photon Switch For Interaction-Free Measurement**
    Poster, *Quantum Communication, Measurement and Computing*, MIT Boston (2002).
    Poster, *Canadian Inst. for Photonic Innovations Annual Meeting*, Quebec City (2002).

30. **Single-Photon-Level Nonlinear Optics Through Quantum Interference**
    Poster, *Coherence and Quantum Optics 8*, Rochester (2001).

31. **Nonlinear Optics at the Quantum Level Via Two-Photon Interference**
    Oral presentation, *International Conference on Squeezed States and Uncertainty Relations*, Boston (2001) – refereed.

32. **Nonlinear optics with less than one photon**
    Poster, 2nd prize, *Photonics Research Ontario Retreat*, Canada (2001).

33. **Nonlinear optics with less than one photon**
    Invited talk, *Physics of Quantum Electronics*, Snowbird, Utah (2001).

34. **100% reflection in less than no time at all**
    Poster, *DAMOP*, Conn. (2000) – refereed.

PATENTS

I. A. Walmsley, B. J. Smith, J. S. Lundeen, P. J. Mosley, G. Puentes, H. B. Coldenstrodt-Ronge, N. L. Thomas-Peter, A. P. Worsley, Calibration of Particle Detectors, US Patent Application: US 2011/0276296 A1, October 12 (2009), International (PCT) Patent Application No. PCT/GB2009/002441.