Rebecca M. Holmes

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Areas of specialization

Optics • Single-photon applications • Aerospace

Education

2017 **PhD – Physics**, University of Illinois at Urbana-Champaign
2011 **BS – Physics**, minor – creative writing, University of North Carolina at Chapel Hill

Experience

2019 - present **Staff scientist**, ISR-2 (Space & Remote Sensing), Intelligence & Space Research division
Los Alamos National Laboratory, Los Alamos, New Mexico

2017 - 2019 **Postdoc**, ISR-1 (Space Science & Applications), Intelligence & Space Research division
Los Alamos National Laboratory, Los Alamos, New Mexico

- Chick Keller Postdoctoral Fellow in Space and Earth Sciences
- Development of new algorithms for single-photon camera data analysis, supporting field experiments, optical modeling.
- Experimental demonstration of hyperspectral intensity correlation interferometry (LDRD 20180658ER): Optical design and alignment including microlenses and a 32×32 single-photon avalanche photodiode (SPAD) array, implementing data collection (MATLAB) and analysis (Python).
- ELROI, a satellite "license plate" based on single-photon detection: Developing analysis algorithms and software tools (Python) for ground and flight tests, analyzing flight test data (Python), link budget and ground station modeling, optical characterization of prototypes, developing requirements and supporting environmental testing of prototypes, maintenance and operation of remote telescope systems.
- ISR Early Career Pitch Day award: Deep space CubeSat mission concept development and orbital modeling in GMAT and Python.

2011 - 2017 **Graduate research assistant**, University of Illinois at Urbana-Champaign

- National Science Foundation Graduate Research Fellow
- Dissertation: Testing the limits of human vision with quantum states of light
(Research advisor: Paul Kwiat)

- Designed and built the first single-photon source optimized for human vision research (a heralded source based on spontaneous parametric downconversion in BBO); developed experimental control software in LabVIEW using digital I/O for input from single-photon detectors and output to laser controls; designed and built an observer viewing station with user-controlled motorized kinematic stages; developed procedures for, scheduled, and supervised experimental trials with human subjects; integrated EEG hardware to measure brain activity; developed data analysis tools in Python and MATLAB to study temporal integration and other aspects of human visual performance at extremely low light levels (NSF grant PHY 519407).
- Served as Laboratory Safety Officer, including chemical and laser safety.
- Graduate mentor for CAPSat, a University of Illinois undergraduate CubeSat mission supported by the NASA Undergraduate Student Instrument Project initiative. Supervised undergraduate work on flight-ready optics and electronics to test annealing techniques for repairing radiation damage to single-photon detectors in space.
- Teaching assistant for Physics 403, Modern Experimental Physics.

Summer 2010 **Undergraduate research assistant**, P-23 (Neutron Science & Technology) at LANL

- MAJORANA collaboration (with Steve Elliott): Built an acoustic testing chamber and quantified effects of microphonic noise on energy resolution in high-purity germanium detectors.

2007 - 2011 **Undergraduate research assistant**, University of North Carolina at Chapel Hill

- UNC Experimental Nuclear and Particle Astrophysics Group (with Reyco Henning and John Wilkerson): Collected and assayed samples to measure gamma rays from fission products in the atmosphere after the 2011 Fukushima reactor accident.
- PROMPT/Skynet robotic telescope network (with Dan Reichart): Rapid-response photometry of gamma-ray burst afterglows with data from robotic telescopes.

2007 - 2011 **Educator**, Morehead Planetarium & Science Center, Chapel Hill, NC

- Presented hundreds of live science demo shows and programs on current issues in science for K-12 school groups and the public, taught summer science camps for children, and wrote a camp curriculum.

Awards

2018 ISR Early Career Pitch Day award ($5k)
2018 Science in "3" Outstanding Presentation Award
2018 Chick Keller Postdoctoral Fellowship in Space and Earth Sciences
2018 LANL Spot Award for service as co-chair of the ISR-1 Seminar Series
2018 LANL Spot Award for customer project
2015 Optical Society of America Emil Wolf Outstanding Student Paper Prize
2012 National Science Foundation Graduate Research Fellowship

Popular writing & outreach

2019 "Seeing the Quantum" - published in *Aeon (April 2019)*
https://aeon.co/essays/an-eye-on-experiments-that-make-quantum-mechanics-visible
2018 "Science on Tap: Honey, have you seen my CubeSat?" - Bradbury Science Museum
2017 "Local Realism Is Dead, Long Live Local Realism?" - published in *Physics World (June 2017)*
2016 "Seeing Single Photons" - published in *Physics World (December 2016)*
2015 "How does an optical fingerprint sensor work?" - Winning video in the Optical Society of America Enabled by Optics competition:
https://youtu.be/CLdrbn8XYIw
2015-2017 Mentored two undergraduate physics majors and a first-year graduate student in the Illinois GPS peer mentoring program.
2011-2017 Answered over 60 physics questions from the public for the University of Illinois "Ask the Physics Van" website:
http://rebeccaholmes.net/askthevan/

Press

2018 "The human eye could help test quantum mechanics" - quoted in *Scientific American*
2018 "How quantum mechanics lets us see, smell, and touch" - quoted in *Discover Magazine*
2017 "Quantum biometric targets the retina" - quoted in *Physics World*
2015 "Quantum technology probes ultimate limits of vision" - quoted in *Nature News*
2015 "Squinting to See a Single Photon" - quoted in *APS News*

Professional skills

- Scientific programming: Python, MATLAB, LabVIEW
- Orbit modeling and analysis: GMAT, STK
- Web development: HTML, CSS/Sass, Ruby on Rails and SQL for dynamic web applications, Jekyll for static web applications

Publications & talks

Journal articles

2018 **R.M. Holmes** and D.M. Palmer, "Extreme background-rejection techniques for the ELROI optical satellite license plate," *Applied Optics*, vol. 58, 2019, pp. 814-825. https://doi.org/10.1364/AO.58.000814

2018 D.M. Palmer and **R.M. Holmes**, "Extremely Low Resource Optical Identifier: A license plate for your satellite," *Journal of Spacecraft and Rockets*, vol. 55, no. 4, 2018, pp. 1014-1023. https://doi.org/10.2514/1.A34106

2017 **R.M. Holmes**, M. Victora, R.F. Wang, and P.G. Kwiat, "Measuring temporal summation in visual detection with a single-photon source," *Vision Research*, vol. 140, 2017, pp. 33–43. https://doi.org/10.1016/j.visres.2017.06.011

2011 S. MacMullin, G.K. Giovanetti, M.P. Green, R. Henning, **R.M. Holmes**, K. Vorren, and J.F. Wilkerson, "Measurement of airborne fission products in Chapel Hill, NC, USA from the Fukushima Dai-ichi reactor accident," *Journal of Environmental Radioactivity*, vol. 112, 2012, pp. 165–70. https://doi.org/10.1016/j.jenvrad.2012.01.026

Invited talks

2019 R.M. Holmes, C.T. Weaver, and D.M. Palmer, "ELROI satellite license plate demonstration on a CubeSat," Proc. SPIE, Advanced Photon Counting Techniques XIII (April 2019) (upcoming)

2018 R.M. Holmes, M. Victora, R.F. Wang, P.G. Kwiat, "Testing the limits of human vision with quantum states of light: past, present, and future experiments," Proc. SPIE 10659, Advanced Photon Counting Techniques XII, 1065903 (14 May 2018)

Other presentations

2019 LANL Finance & Accounting Division FA Connect workshop: "LANL in Space" (May 8, 2019)

2018 LANL P/T Colloquium: "Space traffic management and why satellites need license plates" (December 6, 2018)

2018 DoD Space Experiments Review Board briefing - Chantilly, VA (November 7, 2018)

2018 Air Force Space Experiments Review Board briefing - Albuquerque, NM (August 22, 2018)

2018 R.M. Holmes, C.T. Weaver, D.M. Palmer, "ELROI: A satellite license plate to simplify space object identification," Proceedings of the Advanced Maui Optical and Space Surveillance (AMOS) Technologies Conference 2018. (paper/poster)

2018 R.M. Holmes, C.T. Weaver, D.M. Palmer, "ELROI: A license plate for satellites that anyone can read," Proceedings of the AIAA/USU Conference on Small Satellites, Assuring the Space Ecosystem I, SSC18-XI-01. (paper/talk)

2018 R.M. Holmes, S. Gill, J.Z. Harris, J.S. Lansford, R. Myers, C.T. Weaver, A.P. Zucherman, A.M. Jorgensen, D.M. Palmer, "Progress on ELROI satellite license plate flight prototypes," Proc. SPIE 10659, Advanced Photon Counting Techniques XII, 106590M (14 May 2018) (paper/talk)

2017 R.M. Holmes, et al., "Measuring temporal integration in visual detection using a single-photon source," 2017 Annual Meeting of the Psychonomic Society (poster)

2016 2016 International Conference on Quantum Communication, Measurement and Computing (poster)

2015 R.M. Holmes, et al. "Testing the limits of human vision with single photons," in Frontiers in Optics 2015, OSA Technical Digest (online) (Optical Society of America, 2015), paper FTu5B.5. (talk)

2015 R.M. Holmes, et al. "Studying the lower limit of human vision with a single-photon source," at the 46th Annual Meeting of the APS Division of Atomic, Molecular, and Optical Physics, vol. 60, no. 7, 2015. (talk)

2014 Visual Cognition and Human Performance lunch series at the University of Illinois Psychology Department in Champaign, IL (talk)

2014 R.M. Holmes, et al. "Determining the lower limit of human vision using a single-photon source," in Research in Optical Sciences, OSA Technical Digest (online) (Optical Society of America, 2014), paper QTu2A.2. (talk)

2013 R.M. Holmes, et al. "Determining the lower limit of human vision using a single-photon source," in The Rochester Conferences on Coherence and Quantum Optics and the Quantum Information and Measurement meeting, OSA Technical Digest (online) (Optical Society of America, 2013), paper W6.06. (poster)

2012 2012 Midwest Cold Atom Workshop in Urbana, IL (talk)

2012 R.M. Holmes, et al. "Determining the lower limit of human vision using a single-photon source," in Conference on Lasers and Electro-Optics 2012, OSA Technical Digest (Optical Society of America, 2012), paper QTu1E.8. (talk)

2010 R.M. Holmes, "Microphonics in germanium detectors for MAJORANA," 2010 Fall Meeting of the APS Division of Nuclear Physics (poster)