Brian Williams

Curriculum Vitae

Education

2009–2014 **PhD, Physics**, *University of Tennessee*.

2006–2009 **MS, Physics**, *University of Tennessee*.

1999–2004 **BS, Physics and Mathematics**, *University of Memphis*.

Work/Research Interests

Foremost, I strive to apply math and science to the real world in a meaningful way. Recently, my work has involved experiments with quantum entanglement; Einstein called it "spooky action at a distance". My experimental work has transformed me into an interdisciplinarian, proficient in quantum theory, optics, Bayesian statistics, electronics, FPGAs, Python, C++, and Linux. These abilities make *anything* in the lab or field possible. I am always eager to gain new knowledge and skills when there is an opportunity to do so.

Abilities

- quantum theory
- optics
- Bayesian statistics
- Monte Carlo methods
- C++
- Python
- FPGA
- parallel computing
- PCB design
- Mathematica
- LabView
- LaTeX

Dissertation

title: Nonlocal Polarization Interferometry and Entanglement Detection

advisor: Warren P. Grice

description: My doctoral research included design and experimental implementation of a novel two-photon interferometer, a nonlocal polarization interferometer, capable of detecting entanglement and identifying Bell states statistically. This work was published as an *Editor's Suggestion* in *Physical Review A* [1]. Additional research included an alternative method of characterizing nonlocal correlations using Bayesian inference.

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Research Experience

2017-Present **Research Scientist**, *Oak Ridge National Laboratory*.

I was promoted from a postdoc to a Research Scientist at the beginning of 2017. Since that time, I have worked on a FPGA embedded Linux project that involves DAC, ADC, and DMA components. Additionally, I have done work in silicon photonic capabilities and design.

2015-2017 **Postdoctoral Researcher**, *Oak Ridge National Laboratory*.

As a postdoc I completed three primary research thrusts.

2016 Dr. Travis Humble, Ron Sadlier, and I were the first to demonstrate superdense coding over optical fiber links using a novel complete Bell state measurement, time-polarization hyperentanglement, and common single-photon detectors [2]. We also set a new record for the conditional channel capacity utilizing a single-qubit and linear optics. Our paper was published in *Physical Review Letters* and chosen as an *Editor's Suggestion*. This experiment is the testbed for on-going quantum networking research [3] with Army Research Laboratories.

2016 Dr. Pavel Lougovski and I investigated an approach to Bayesian mean estimation of quantum states. Our novel analysis reduces burdens associated with experimental asymmetries and inefficiencies. Our method can be applied to quantum systems of any dimension. Our paper detailing this approach was published in *New Journal of Physics* [4].

2015 Dr. Travis Humble, Keith Britt, and I demonstrated a quantum tamper-seal [5] using a two-photon entangled state, a partial Bell state measurement, and a novel entanglement witness. *Physical Review Applied* published our research and it was chosen as a *Physics* focus story.

2010–2015 **Research Assistant**, *University of Tennessee / Oak Ridge National Laboratory*.

As a student, I researched nonlocal two-photon interference, upconversion of two-photon states, Hong-Ou-Mandel interference, and Bayesian inference. I gained practical experience designing and building prototype optical systems [6] and configuring FPGA devices for photon time-stamping [7].

2003–2004 **Research Assistant**, *University of Memphis*, Memphis, TN.

As an undergraduate I worked as a research assistant in the field of computational fluid dynamics, specifically Poiseuille flow.

Other Work Experience

2005–2009 **Health Physicist**, *State of Tennessee Department of Environment and Conservation Division of Radiological Health*, Knoxville, TN.

As a Health Physicist my duties included inspecting facilities licensed to use, manufacture, prepare, recycle, and dispose of radiation producing materials and machines.

1999–2003 **Assistant Manager**, *J. Goodman and Associates*, Memphis, TN.

This employer archived paper documents by scanning and storing them on digital media. My duties included updating databases on site for customers, managing archived data, preparing documents for archiving, and scanning documents.

Outside Interests and Experience

Mountains

NOLS In 2000, I spent a month mountaineering in the Wind River Range of Wyoming with the National Outdoor Leadership School.

AMGA While living in Memphis, TN I earned a certification from the American Mountain Guide Association. With this knowledge I spent two years teaching introductory rock climbing with the Memphis Mountaineers, a nonprofit organization.

Running

100's I have completed the Leadville Trail 100 Mile and the Thunder Rock 100 Mile trail races.

AT In 2011, I ran the 72 mi length of Appalachian Trail within the Smoky Mountain National Park in less than 17 hrs which included 18,000 feet of vertical gain.

CT50k Since 2013, I have directed the Cumberland Trail 50k footrace. The Cumberland Trail 50k is an adopter/maintainer for the race course section of the Cumberland Trail. As such, we provide trail maintenance and financial support.

Publications

[1] Brian P. Williams, Travis S. Humble, and Warren P. Grice. Nonlocal polarization interferometer for entanglement detection. *Phys. Rev. A*, 90:042121, Oct 2014.

[2] Brian P. Williams, Ronald J. Sadlier, and Travis S. Humble. Superdense coding over optical fiber links with complete bell-state measurements. *Phys. Rev. Lett.*, 118:050501, Feb 2017.

[3] Venkat R. Dasari, Ronald J. Sadlier, Ryan Prout, Brian P. Williams, and Travis S. Humble. Programmable multi-node quantum network design and simulation, 2016.

[4] Brian P Williams and Pavel Lougovski. Quantum state estimation when qubits are lost: a no-data-left-behind approach. *New Journal of Physics*, 19(4):043003, 2017.

[5] Brian P. Williams, Keith A. Britt, and Travis S. Humble. Tamper-indicating quantum seal. *Phys. Rev. Applied*, 5:014001, Jan 2016.

[6] W. P. Grice, P. G. Evans, B. Lawrie, M. Legré, P. Lougovski, W. Ray, B. P. Williams, B. Qi, and A. M. Smith. Two-party secret key distribution via a modified quantum secret sharing protocol. *Opt. Express*, 23(6):7300–7311, Mar 2015.

[7] Raphael C. Pooser, Dennis D. Earl, Philip G. Evans, Brian Williams, Jason Schaake, and Travis S. Humble. Fpga-based gating and logic for multichannel single photon counting. *Journal of Modern Optics*, 59(17):1500–1511, 2012.