

February 28, 2017

CURRICULUM VITAE

Dr. Benjamin J. McMorran

Assistant Professor

Department of Physics

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Google Scholar page: click [here](#)

EDUCATION

- 2009 Ph.D. Physics, *University of Arizona (UA), Tucson, AZ*, Advisor: Alexander D. Cronin
Dissertation: "Electron diffraction and interferometry using nanostructures"
- 2005 M.S. Physics, *UA, Tucson, AZ*
- 2000 B.S. Applied Physics, B.S. Engineering Physics, *Oregon State University (OSU), Corvallis, OR*

SCIENTIFIC WORK EXPERIENCE

- 2011 – present **Assistant Professor** – *Department of Physics, University of Oregon, Eugene, OR*
Field of Specialization: Experimental Condensed Matter and Optical Physics
Research Interests: electron physics, electron vortex beams, matter wave interferometry, electron microscopy, nanomagnetic imaging, magnetic skyrmions
- 2009 – 2011 **Postdoctoral Research Associate** – *Electron Physics Group, CNST, NIST, Gaithersburg, MD*
Nanoscale magnetization studies, spintronics, scanning electron microscopy with electron spin polarization analysis (SEMPA), transmission electron microscopy (TEM), theory and experiments with electron vortex beams, fabrication of nanoscale diffractive optics
main contacts: Dr. John Unguris and Dr. Jabez McClelland
- 2003 – 2009 **Graduate Research Associate** – *Atom Interferometry Group, Dept. of Physics, UA, Tucson, AZ*
Electron and atom interferometry, theory and measurement of coherence in light and matter waves, construction of low-energy electron microscope
main contact: Prof. Alex D. Cronin
- 2004 – 2005 **Graduate Research Assistant** – *High Energy Physics Group, Dept. of Physics, UA, Tucson, AZ*
Detector development (D0 at Fermilab), calorimetry, data visualization (ATLAS at LHC)
main contacts: Prof. Ken Johns (D0) and Prof. Mike Shupe (ATLAS)
- 1999 – 2003 **Engineer** – *ViewPlus Technologies, Corvallis, OR*
R&D, product design, and user support for enabling technologies for the visually impaired.
main contact: Dr. John Gardner
- 1997 – 1998 **Physics Engineer Intern** – *Oregon Freeze Dry, Albany, OR*
Vacuum sublimator array power load simulations, food processing equipment design.
main contact: Mike Neary
- 1997 **Undergraduate Research Assistant** – *Ocean Optics Group, COAS, OSU, Corvallis, OR*
Design and construction of automated mobile sea water testing platform.
main contact: Prof. W. Scott Pegau
- 1997 **Undergraduate Research Assistant** – *Dept. of Mechanical Engineering, OSU, Corvallis, OR*
Development of stroboscopic tools for high speed rotor imbalance testing.
main contact: Prof. William F. Reiter

PUBLICATIONS

Refereed Journal Articles

- T. R. Harvey, V. Grillo, B. J. McMorran, "Stern-Gerlach-like approach to electron orbital angular momentum measurement," *Phys. Rev. A* **95**, 21801 (2017)
- B. J. McMorran, T. R. Harvey, M. P. J. Lavery, "Efficient sorting of free electron orbital angular momentum," *New Journal of Physics* **19**, 23053 (2017)
- J. J. Chess, S. A. Montoya, E. E. Fullerton, B. J. McMorran, "Determination of domain wall chirality using in situ Lorentz transmission electron microscopy," *AIP Advances* **7**, 56807 (2017)
- S. A. Montoya, S. Couture, J. J. Chess, J. C. T. Lee, N. Kent, D. Henze, S. K. Sinha, M.-Y. Im, S. D. Kevan, P. Fischer, B. J. McMorran, V. Lomakin, S. Roy, and E. E. Fullerton, "Tailoring magnetic energies to form dipole skyrmions and skyrmion lattices," *Physical Review B* **95**, 024415 (2017)
- Invited article:** B. J. McMorran, Amit Agrawal, Peter A. Ercius, Vincenzo Grillo, Andrew A. Herzing, Tyler R. Harvey, Martin Linck, Jordan S. Pierce, "Origins and Demonstrations of Electrons with Orbital Angular Momentum", *Philosophical Transactions of the Royal Society A* special issue: 'Optical angular momentum' **375**, 20150434 (2017)
- Invited article:** B. J. McMorran, "Structured Electron Matter Waves" in "Roadmap on structured light", a special issue of *Journal of Optics* **19**, 13001 (2017)
- J. C. T. Lee, J. J. Chess, S. A. Montoya, X. Shi, N. Tamura, S. K. Mishra, P. Fischer, B. J. McMorran, S. K. Sinha, E. E. Fullerton, S. D. Kevan, S. Roy, "Synthesizing skyrmion bound pairs in Fe-Gd thin films," *Applied Physics Letters* **109**, 022402 (2016)
- C. Ophus, J. Ciston, J. Pierce, T. R. Harvey, J. Chess, B. J. McMorran, C. Czarnik, H. H. Rose, and P. Ercius, "Efficient linear phase contrast in scanning transmission electron microscopy with matched illumination and detector interferometry," *Nature Communications* **7**, 10719 (2016)
- T. R. Harvey, J. S. Pierce, Amit K. Agrawal, P. Ercius, M. Linck, B. J. McMorran, "Efficient diffractive phase optics for electrons", *New Journal of Physics* **16**, 093039 (2014)
- G. M. Gallatin, B. McMorran, "Propagation of vortex electron wave functions in a magnetic field", *Phys. Rev. A* **86**, 012701 (2012)
- C. Klose, T. S. Khaire, Y. Wang, W. P. Pratt, N. O. Birge, B. J. McMorran, T. P. Ginley, J. A. Borchers, B. J. Kirby, B. B. Maranville, and J. Unguris, "Optimization of Spin-Triplet Supercurrent in Ferromagnetic Josephson Junctions", *Phys. Rev. Lett.* **108**, 127002 (2012)
- J.-Y. Chauleau, B. J. McMorran, R. Belkhou, N. Bergéard, T. O. Mendes, M. Á. Niño, A. Locatelli, J. Unguris, S. Rohart, J. Miltat, and A. Thiaville, "Magnetization textures in NiPd nanostructures", *Phys. Rev. B* **84**, 094416 (2011)
- A. Agrawal, C. Susut, G. Stafford, U. Bertocci, B. McMorran, H. J. Lezec, and A. A. Talin, "An Integrated Electrochromic Nanoplasmonic Optical Switch", *Nano Lett.* **11**, 2774 (2011)
- B. J. McMorran, A. Agrawal, I.M. Anderson, A.A. Herzing, H.J. Lezec, J.J. McClelland, J. Unguris, "Electron Vortex Beams with High Quanta of Orbital Angular Momentum", *Science* **331**, 192 (2011)
- J.E. Davies, P. Morrow, C.L. Dennis, J.W. Lau, B. McMorran, A. Cochran, J. Unguris, R.K. Dumas, P. Greene, Kai Liu, "Reversal of patterned Co/Pd multilayers with graded magnetic anisotropy", *J. App. Phys.* **109**, 07B909 (2011)
- B. J. McMorran, A.C. Cochran, R.K. Dumas, K. Liu, P. Morrow, D.T. Pierce, J. Unguris, "Measuring the effects of low energy ion milling on the magnetization of Co/Pd multilayers using SEMPA", *J. App. Phys.* **107**, 09D305 (2010)
- B. McMorran, A.D. Cronin, "An Electron Talbot Interferometer", *New Journal of Physics* **11**, 033021 (2009)

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B. McMorran, A.D. Cronin, "A model for partial coherence and wavefront curvature in grating interferometers", *Phys. Rev. A* **78**, 013601 (2008)

A.D. Cronin, B. McMorran, "Electron interferometry with nanogratings", *Phys. Rev. A* **74**, 061602(R) (2006)

B. McMorran, J.D. Perreault, T.A. Savas, A. Cronin, "Diffraction of 0.5 keV electrons from free-standing transmission gratings", *Ultramicroscopy* **106**, 356 (2006)

Submitted for Review

V. Grillo, T. R. Harvey, F. Venturi, J. S. Pierce, R. Balboni, F. Bouchard, G. Gazzadi, S. Frabboni, A. H. Tavabi, Z. Li, R. E. Dunin-Borkowski, R. W. Boyd, B. J. McMorran, E. Karimi, "Observation of nanoscale magnetic fields using twisted electron beams" *Nat. Comm.*, **submitted** (submitted 12/2016)

J. J. Chess, S. A. Montoya, T. R. Harvey, C. Ophus, S. Couture, V. Lomakin, E. E. Fullerton, and B. J. McMorran, "A streamlined approach to mapping the magnetic induction of skyrmionic materials," [arXiv:1608.06000](https://arxiv.org/abs/1608.06000) (2016); *Ultramicroscopy*, **accepted/in press** (submitted 10/2016)

M. Linck, C. Ophus, P. Ercius, B. J. McMorran, "Holographic Aberration Correction in an Electron Microscope", *Ultramicroscopy*, **under review** (submitted 08/2016)

T. R. Harvey, J. S. Pierce, J. J. Chess, B. J. McMorran, "Demonstration of electron helical dichroism as a local probe of chirality", [arXiv:1507.01810](https://arxiv.org/abs/1507.01810) (2015); *Phys. Rev. Lett.* **under review** (submitted 06/2015)

In Progress (completed draft stage)

F. S. Yasin, T. R. Harvey, J. J. Chess, J. S. Pierce, B. J. McMorran, "Separated-Path Mach-Zehnder Interferometer for Electron Matter Waves in a Transmission Electron Microscope", (revising for submission to *Applied Physics Letters*)

J. S. Pierce, B. J. McMorran, "Holographic Apodization for Gaussian Electron Beams", (revising for submission to *Applied Physics Letters*)

B. J. McMorran, K. Madsen, C. Webb, J. S. Pierce, "Electron Orbital Interferometry", (revising for submission to *Physical Review X*)

S. A. Montoya, S. Couture, J. J. Chess, J. C. T Lee, N. Kent, D. Henze, M.-Y. Im, S.D. Kevan, P. Fischer, B. J. McMorran, S. Roy, V. Lomakin, and E.E. Fullerton "Resonant properties of dipole stabilized skyrmions in amorphous Fe/Gd multilayers", (revising for submission to *Physical Review X*)

Published Refereed Conference Papers

F. S. Yasin, T. R. Harvey, J. J. Chess, J. S. Pierce, B. J. McMorran, "Development of STEM-Holography," *Microsc. Microanal.* **22**, 506 (2016)

J. Chess, S. Montoya, J. Lee, S. Roy, S. Kevan, E. Fullerton, B. McMorran, "Observation of Skyrmions at Room-temperature in Amorphous Fe/Gd Films," *Microsc. Microanal.* **21**, 1649 (2015)

V. Grillo, E. Karimi, R. Balboni, G. C. Gazzadi, F. Venturi, S. Frabboni, J. S. Pierce, B. J. McMorran, R. W. Boyd, "Electron holograms encoding amplitude and phase for the generation of arbitrary wavefunctions," *Microsc. Microanal.* **21**, 503 (2015).

V. Grillo, E. Rotunno, B. McMorran, S. Frabboni, "Propagation of Bessel Beams along Atomic Columns in Crystal: a Bloch Wave and Multi-slice Analysis," *Microsc. Microanal.* **21**, 1889 (2015)

T. R. Harvey, V. Grillo, B. J. McMorran, "An Orbital Angular Momentum Spectrometer for Electrons," *Microsc. Microanal.* **21**, 23 (2015)

P. Ercius, T. Harvey, J. Pierce, J. Chess, M. Linck, and B. McMorran, "Atomic-resolution Imaging Using Cs-corrected Vortex Beams", *Microsc. Microanal.* **20**, 84 (2014)

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- T. R. Harvey, J. Chess, J. S. Pierce, P. Ercius, B. J. McMorran, “Characterization of Electron Orbital Angular Momentum Transfer to Nanoparticle Plasmon Modes”, *Microsc. Microanal.* **20**, 68 (2014)
- D. Shook, B. J. McMorran, “Propagation of Free Electrons Carrying Orbital Angular Momentum Through Magnetic Lenses”, *Microsc. Microanal.* **20**, 292 (2014)
- J. S. Pierce, C. Wright, T. R. Harvey, B. J. McMorran, “Creation of High Resolution Electron Diffraction Gratings using FIB and E-Beam Techniques”, *EIPBN Proceedings*, pp. P08–06, (2014)
- T. R. Harvey, J. S. Pierce, T. S. Yahn, P. A. Ercius, B. J. McMorran, “Electron Orbital Angular Momentum Transfer to Nanoparticle Plasmon Modes”, *Microsc. Microanal.* **19**, 1186 (2013)
- J. S. Pierce, T. R. Harvey, T. S. Yahn, B. J. McMorran, “High Efficiency Electron Diffractive Optics”, *Microsc. Microanal.* **19**, 1188 (2013)
- T. Yahn, J. S. Pierce, T. R. Harvey, B. J. McMorran, “Addition, Subtraction, and Analysis of Orbital Angular Momentum in Electron Vortex Beams”, *Microsc. Microanal.* **19**, 1166 (2013)
- B. McMorran, A. Agrawal, I. Anderson, A. Herzing, H. Lezec, J. McClelland, J. Unguris, “Electron Beams Carrying Quantized Orbital Angular Momentum”, in *Laser Science*, OSA p. LWL1 (2011)
- B. McMorran, D. Pierce, J. Unguris, “Depth Profiling Magnetic Structure Using Scanning Electron Microscopy with Polarization Analysis (SEMPA)”, *Microsc. Microanal.* **16**, suppl. 2, 1862 (2010)
- B. McMorran, D. Wanegar, A. Cronin, “Low Energy Electron Holography of Charged Tip”, *Microsc. Microanal.* **14**, (Suppl. 2) 350 (2008)
- B. McMorran, A. Cronin, “Very Low Energy TEM Diffraction of Nanostructures”, *Microsc. Microanal.* **14**, (Suppl. 2) 824 (2008)
- B. McMorran, A. Cronin, “Measurement of Electron Beam Coherence Using a Lau Interferometer”, *Microsc. Microanal.* **14**, (Suppl. 2) 828 (2008)
- B. McMorran, A. Cronin, “Electron diffraction and interferometry with nano-gratings”, *Microsc. Microanal.* **13**, (Suppl. 2) 1222 (2007)

PATENTS

- B. McMorran et al., “Device and method for creating Gaussian aberration-corrected electron beams”, U.S Patent 9240255 (2015)
- B. McMorran, “System and method for producing and using multiple electron beams with quantized orbital angular momentum in an electron microscope”, U.S. Patent 8680488 (2014)

SELECTED PRESENTATIONS

Invited Talks

- Electron Holography Workshop, Hitachi Advanced Research Campus, Hatoyama, Saitama Prefecture, Japan, Feb 17, 2017: “Electron Interferometry with Sculpted Electrons”
- Physics of Quantum Electronics (PQE) Conference, Snowbird, UT, Jan 10, 2017: “Electron Vortices and Other Sculpted Electrons: Production, Measurement, and Application” (presented remotely)
- Willamette University Physics Colloquium, Salem, OR, Nov 18, 2016: “Sculpting Free Electrons”
- University of Oregon Physics Colloquium, Eugene, OR, Oct 20, 2016: “Spinning, Swirling, Twisting: Adventures with Structured Electrons”
- Moore Foundation Workshop on Free Electron Quantum Optics, Half Moon Bay, CA, Oct 15, 2016: “Sculpted Electrons: Electron Vortices and Other Applications”
- ALS Workshop on Chirality, Symmetry Breaking and Topological Defects, Lawrence Berkeley National Lab, Berkeley, CA, Oct 5, 2016: “Investigating Topology with Helical Electrons and Photons” ([link](#))
- ALS Workshop on Tomography of Vector Fields, Lawrence Berkeley National Lab, Berkeley, CA, Oct 5, 2016: “Investigating Topology with Helical Electrons and Photons” ([link](#))

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JQI Informal Workshop on Matter Wave Interferometry, Joint Quantum Institute, University of Maryland, MD, Oct 1, 2016: “Electron Interferometry & Vortices” ([link](#))

620th Heraeus Seminar on Interaction of Shaped Electron Wavefunctions with Light and Matter, Physik-Zentrum Bad Honnef, Germany, Jun 20, 2016: “Sculpted electron beams and their applications” ([link](#))

Integrated Imaging Initiative (I3) Seminar, Argonne National Lab, IL, Apr 11, 2016: “Investigations of topological states in electron wavefunctions and magnetization” ([link](#))

3rd International Conf. on Optical Angular Momentum (ICOAM), City College of New York, NY, Aug 7, 2015: “Investigations of Free Electrons with Quantized Orbital Angular Momentum” ([link](#))

LANL Condensed Matter Science Colloquium, Los Alamos National Lab, Los Alamos, NM, May 13, 2015: “Investigations of topological states in electron wavefunctions and magnetization”

Linfield Science Colloquium, Linfield College, McMinnville, OR, Apr 30, 2015: “Imaging Magnets at the Nanoscale with Sculpted Electrons”

Physics Slam public event, University of Oregon, Eugene, OR, Apr 8, 2015: “Quantum Sculptures: Shaping Matter Waves at the Picoscale”

Spring Meeting of the Oregon Section of the AAPT, University of Oregon, Eugene, OR, Mar 7, 2015: “Experiments with interactive & flipped classes in university calculus-based introductory physics”

Accelerator Division Seminar, Jefferson Lab, Newport News, VA, Feb 2, 2015: “Production and Dynamics of Free Electron Vortex Beams with Quantized Angular Momentum”

PSU Physics Colloquium, Portland State University, Portland, OR, Jan 12, 2015: “Sculpted Free Electrons”

Reed Physics Colloquium, Reed College, Portland, OR, Nov 19, 2014: “Experiments with Free Electron Vortices”

Electron & Scanning Probe Microscopies Principle Investigators’ Meeting, Gaithersburg, MD, Oct 20, 2014: “Electron Microscopy With Vortex Beams Carrying Orbital Angular Momentum”

Materials & Optics Seminar, Physics Department, Oregon State University, Corvallis, OR, Oct 15, 2014: “Experiments with Free Electron Vortices”

Advanced Light Source (ALS) Workshop on Magnetic Heterogeneity, Lawrence Berkeley National Lab, Berkeley, CA, Oct 7, 2014: “Observation of topological states in magnetization and free electrons in electron microscopy”

UC-Berkeley Department of Physics 290k Seminar, Berkeley, CA, Oct 6, 2014: “Sculpted free electron orbitals as a probe of magnetization and plasmons”

Molecular Foundry/NCEM Annual Meeting, Lawrence Berkeley National Lab, Berkeley, CA, Aug 26, 2014: “Investigations of Electron Vortex Beams with Quantized Orbital Angular Momentum”

Intel Components Research Seminar, Hillsboro, OR, May 18, 2014: “Quest for Magnetic Imaging using Structured Illumination Electron Microscopy”

Advanced Structural & Chemical Imaging (ASCI) Symposium, University of Washington, Seattle, WA, May 28, 2014: “Current status of atomic resolution STEM imaging using vortex beams”

Tonomura FIRST International Symposium on Topological Quantum Technology, University of Tokyo, Tokyo, Japan, Jan 30, 2014: “Investigations of Electron Vortex Beams Carrying Orbital Angular Momentum”

Microscopy Society of Canada Annual Meeting, University of Victoria, Victoria, BC, Canada, June 19, 2013: “Investigations of Electron Vortex Beams Carrying Orbital Angular Momentum”

2nd International Conf. on Optical Angular Momentum (ICOAM), Glasgow, UK, June 3, 2013: “Manipulation and Detection of OAM in Electron Vortex Beams” ([link](#))

Colloquia, Wesleyan University (Middletown), and Trinity College (Hartford), CT, Feb 14&15, 2013: “Experiments with Free Electron Vortex States”

PNNL Chemical & Materials Sciences Seminar, EMSL, PNNL, Richland, WA, Dec. 12, 2012:

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“Novel Electron Microscopy using Diffractive Electron Optics”
APS-Northwest Section Meeting, University of British Columbia, Vancouver, BC, October 18, 2012:
“Inverse Electron Holography: Experiments with Physical Hologram Gratings”
LBNL NCEM/Molecular Foundry Users’ Meeting, LBNL, Berkeley, CA, October 5, 2012:
“Inverse Electron Holography: Experiments with Physical Hologram Gratings”
Carbon Cycle 2.0 Seminar, LBNL, Berkeley, CA, June 14, 2012:
“Electron Beams with Angular Momentum and Their Application to Magnetic Imaging”
Physics Colloquium, Oregon State University, Corvallis, OR, April 30, 2012:
“Electron Beams with Angular Momentum and Their Application to Magnetic Imaging”
Physics Colloquium, University of Nebraska-Lincoln, Lincoln, NE, April 12, 2012:
“Electron Beams with Angular Momentum and Their Application to Magnetic Imaging”
56th Conference on Magnetization and Magnetic Materials (MMM 2011), Scottsdale, AZ, Nov 1, 2011:
“Electron Beams with Orbital Angular Momentum and Their Application to Magnetic Imaging”
Frontiers in Optics 2011/Laser Science XXVII (FiO/LS 2011), San Jose, CA, October 19, 2011:
“Electron Beams Carrying Quantized Orbital Angular Momentum”
EIPBN Meeting, Las Vegas, NV, June 2, 2011:
“Electron Beams with Helical Wavefronts and Quantized Angular Momentum”
Argonne National Lab Users’ Meeting, ANL, Argonne, IL, May 2, 2011:
“Electron Beams with Orbital Angular Momentum”
CLEO Meeting, Baltimore, MD, May 2, 2011:
“Electron Laguerre-Gaussian Beams”
Neutron Interactions and Dosimetry Seminar, NCNR, NIST, Gaithersburg, MD, March 15, 2011:
“Electron Beams with Orbital Angular Momentum”
Physics Colloquium, Northern Arizona University, Flagstaff, AZ, March 1, 2011:
“A New Spin on the Electron Beam: Demonstration and Applications for Screw-Shaped Electrons”
Physics Colloquium, University of Oregon, Eugene, OR, February 17, 2011:
“Electron Vortex Beams, and Other Adventures in Matter Wave Sculpting”
NCEM Seminar, National Center for Electron Microscopy, LBNL, Berkeley, CA, February 15, 2011:
“Electron Beams with Orbital Angular Momentum”
Fermilab Research Techniques Seminar, Batavia, IL, May 20, 2008:
“Matter Wave Interferometry with Poorly Collimated Beams”
Low-Energy Seminar, University of Arizona, October 2006:
“Interferometry with semi-coherent beams”
AMOP Seminar, University of Nebraska-Lincoln, February 2005:
“Diffraction of ‘low energy’ electrons from free-standing transmission gratings”

Contributed Talks

APS March Meeting, Dallas, TX, March 2011:
“Generation and Characterization of Free Electron Vortices”
11th Joint MMM/Intermag, Washington, D.C., January 2010:
“Quantitative images of three-dimensional magnetization of Co/Pd multilayers using SEMPA”
Microscopy & Microanalysis annual meeting, Albuquerque, NM, August 2008:
“Very Low Energy TEM Diffraction of Nanostructures”
Microscopy & Microanalysis annual meeting, Albuquerque, NM, August 2008:
“Measurement of Electron Beam Coherence Using a Lau Interferometer”
Microscopy & Microanalysis annual meeting, Ft. Lauderdale, FL, August 2007:
“Electron diffraction and interferometry with nanogratings”

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DAMOP, Knoxville, TN, May 2006:

“Diffraction of 0.5 keV electrons from free-standing transmission gratings”

Selected Poster Presentations

First Place poster prize: Advances in Instrumentation, Microscopy & Microanalysis annual meeting, Columbus, OH, August 2016: F. S. Yasin *et al.*, "Development of STEM-Holography,"

Poster award: 59th Conf. on Magnetism and Magnetic Materials (MMM 2014), Honolulu, HI, Nov 2014: J. J. Chess *et al.*, “Employing Hermite-Gaussian beams to probe magnetic materials with atomic resolution”

56th Conf. on Electron, Ion, & Photon Beam Tech. and Nanofab. (EIPBN), Waikaloa, HI, May 9, 2012: “Sculpting Electron Beam Profile and Phase with Nanofabricated Diffractive Optics”

56th Conf. on Magnetization and Magnetic Materials (MMM 2011), Scottsdale, AZ, Nov 2, 2011: “Evidence for Spin Flop Transition in Josephson Junctions with a Synthetic Antiferromagnetic Layer”

Microscopy & Microanalysis annual meeting, Nashville, TN, August 2011:

“Electron Beams with Orbital Angular Momentum”

Microscopy & Microanalysis annual meeting, Portland, OR, August 2010:

“Depth Profiling Magnetic Structure using Scanning Electron Microscopy with Polarization Analysis”

DAMOP, Charlottesville, VA, March 2009:

“Talbot Interferometer for Free Electrons”

Arizona Imaging & Microscopy Society annual meeting, Flagstaff, AZ, April 2008:

“Very low energy TEM: diffraction from nanostructures and holography of weak electric fields”

Microscopy & Microanalysis annual meeting, Richmond, VA, July 2009:

“A Talbot Interferometer for Free Electrons”

DAMOP, Calgary, Alberta, Canada, June 2007:

“A model for partial coherence and wavefront curvature in grating interferometers”

Arizona Imaging & Microscopy Society annual meeting, Tucson, AZ, March 2006:

“Diffraction of 0.5 keV electrons from free-standing transmission gratings”

DAMOP, Tucson, AZ, April 2004:

“The Aharonov-Casher effect is not a Which-Way experiment”

PUBLICITY

Related to 2016 *Nat. Comm.* paper on MIDI-STEM imaging technique:

“New form of electron-beam imaging can see elements that are 'invisible' to common methods”,

[PhysOrg.com](#), [EurekAlert](#), [ScienceDaily](#) (Feb. 29, 2016)

Related to undergraduate research advising:

“Modus Operandi with Ben McMorran”, [Modus Operandi](#) (July, 2015)

Related to the April 2015 UO Physics Slam:

“Straub Hall filled for UO Physics Slam”, [Daily Emerald](#) (Apr. 9, 2015)

“Physics Slam is shaping up to be a campus hit” by Greg Bolt, [Around the O](#) (Apr. 2, 2015)

Related to 2014 undergraduate research:

“Process of discovery yields results in lab, and in life”, by Carly Wright, [Cascade magazine](#) (Oct. 2014)

Related to UO 2014 Clusters of Excellence Initiative:

“It’s a small world with a very big upside”, by Diane Dietz, [Register Guard](#), (Jul. 7, 2014)

Related to DOE Early Career Award:

“McMorran Wins Department of Energy Early Career Award”, [Around the O](#), (Jul. 2013)

Related to 2011 *Science* paper on electron vortex beams:

“Back Scatter” page, *Physics Today*, (Mar. 2011)

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- “A New Twist for Electron Beams”, by Rodney A. Herring, *Science* **331**, 155 (Jan. 2011)
“A New Twist on the E-beam”, by Mark Esser, Photonics.com, PhysOrg, NIST Techbeat (Jan. 2011)
“Electron beams do the twist”, by Belle Dumé, [Physics World](#), [nanotechweb.org](#) (Jan. 2011)
“Twisted electron beams could lead to manipulating individual atoms and electrons”, [Foresight Institute](#)
“A twisted way to take pictures”, by Marissa Cevallos, [ScienceNews](#) (Jan. 2011)
“Electron Microscopes Get Twisty”, by Patricia Daukantas, [Optics & Photonics News](#) (Jan. 2011)

GRANTS AND AWARDS

- 2016 – 2019 NSF Grant No. PHY-1607733, AMO-E program – \$544k over 3 years:
“Quantum Superpositions of Free Electron Orbital Angular Momentum”
2016 – 2018 Murdoch Foundation Partners in Science - \$15k for 2 years
2015 – 2016 Voxel Inc./Vadient contract - \$7249
2014 – 2015 Voxel Inc./Vadient SBIR phase I, NASA - \$125k (total), \$38k subaward to UO
2013 – 2018 Early Career Award #DE-SC0010466, U.S. Department of Energy (DOE), Office of Science, Basic Energy Sciences (BES) – \$750k over 5 years
“Electron Microscopy with Vortex Beams Carrying Orbital Angular Momentum”
2012 – 2013 Lab-Directed Research & Development (LDRD) grant, Carbon Cycle 2.0 Initiative, LBNL – \$119k (total), \$20k subaward to UO
2011 – 2012 LDRD, LBNL – \$119k (total), \$20k subaward to UO
2009 NRC Postdoctoral Fellowship (awarded, but declined by McMorran), NIST
2008 Faculty Small Grants Award (coauthor), University of Arizona Foundation
2008 Distinguished Scholar Award, Microbeam Analysis Society
2007 – 2008 Imaging Fellowship, Arizona Technology and Research Initiative
2007 DAMOP student travel award, American Physical Society
2007 Presidential Student Award, Microscopy Society of America
2006 Outstanding Graduate Student Colloquium Presentation Award, University of Arizona
1995 – 1999 Presidential “Competitive Edge” Scholarship, Oregon State University
1995 – 1997 Academic Scholarships from Chevron, Elks Lodge, Cinemark, and Crater Foundation

SELECTED SYNERGISTIC ACTIVITIES

- ongoing reviewer for *Science*, *Nature*, *Nature Communications*, *Physical Review Letters*, *New Journal of Physics*, *Physical Review A*, *Physical Review X*, *Microscopy & Microanalysis*, *Annalen der Physik*, *Analytical & Bioanalytical Chemistry*, DOE sponsored research proposal review
2015 – present Molecular Foundry Proposal Review Board, Berkeley National Lab
2014 – 2015 Symposium Organizer and Session Chair: “Higher-Order Electron Beams”, Microscopy & Microanalysis (M&M) 2015, Portland, OR
2014 Symposium Organizer, Session Chair, and Editor: “Magnetic Microscopy”, International Conference on Magnetism and Magnetic Materials (MMM) 2014, Honolulu, HI
2011 Session Chair and Editor: “Magnetic Microscopy”, MMM 2011, Scottsdale, AZ
2011 Session Chair: “Orbital Angular Momentum and Applications”, FiO/LS 2011 San Jose, CA

ACADEMIC SERVICE

- 2015 – present Leadership Committee, Oregon Center for Optical, Molecular, and Quantum Sciences
2015 – present Faculty Co-Advisor, Society of Physics Students (SPS) Leadership Committee
2015 – present Graduate Applications Committee, Grad. Internship Program - optics
2013 – present UO CAS General Science Faculty Advisory Committee

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2012 – present UO CAMCOR Faculty Advisory Committee
2012 – present Chair, NanoFabrication (FIB and EBL) Facility Faculty Advisory Committee
2012 – present Chair, High Resolution Microscopy (TEM) Facility Faculty Advisory Committee
2012 – present Chair, Physics Graduate Recruitment Committee (chair since 2015)
2012 – present Mad Duck Science Fridays, Summer Academy to Inspire Learning (SAIL) public educator
2012 – 2015 University of Oregon Science Literacy Program faculty member
2012 – 2014 Graduate Applications Committee, Dept. of Physics, University of Oregon
2004 – 2006 graduate representative, Dept. of Physics Faculty Search Committee, University of Arizona
2004 – 2006 representative, Dept. of Physics Graduate Council, University of Arizona
2004 – 2008 College of Science Public Lab Tours, University of Arizona

PROFESSIONAL AFFILIATIONS

2008 – present Microbeam Analysis Society
2007 – present Microscopy Society of America
2006 – 2009 Arizona Imaging and Microanalysis Society
2004 – present American Physical Society (DAMOP and DCMP)
1998 – present Sigma Pi Sigma

RESEARCH ADVISING & PROFESSIONAL MENTORING

Postdoctoral Scholar Sponsorship:

2014 – 2015 Vincenzo Grillo (CNR-Modena) – electron microscopy with sculpted electrons beams

PhD Research Advising:

2016 – present Alice Greenberg – nanoparticle manipulation with electron vortex beams
2016 – present Saul Propp – coherence and evolution of relativistic structured electrons
2015 – present Galen Gledhill (FEI Co.) – quantum properties of charged particle beams
2014 – present Fehmi Yasin – electron Mach-Zehnder interferometry, [NSF Graduate Research Fellow](#)
2014 – 2016 Spencer Alexander – X-ray interferometry and wavefront engineering
2013 – present Jordan Chess – analysis of topological magnetic textures
2012 – present Jordan Pierce – holographic electron wavefront engineering
2011 – present Tyler Harvey – electron microscopy with vortex beams, expected graduation Fall '16

Master's Research Advising:

2014 – 2015 Jenna Wardini – low loss STEM-EELS using vortex beams
2014 – 2015 Nicholas Anthony – 3D-printed GRIN optics, scanning optical interferometry
2014 Galen Gledhill – Voxel/NASA project, FDTD simulation of plasmonic NPs
2014 Matson Thieme – Voxel/NASA project, Zernike polynomials and aberrations
2014 Ryan Lane – Voxel/NASA project, scanning Mach-Zehnder interferometry
2014 Nicholas Neibauer – Voxel/NASA project, Mach-Zehnder interferometry
2013 – 2015 David Shook – electron vortex beam optics simulations & experiments
2012 – 2013 Tyler Yahn – computer-generated electron holography

Undergraduate Research Advising:

2016 Matthew Bowden – holographic apodization using binary gratings, [NSF REU](#)
2016 Hannah DeVylde – nanoparticle manipulation using electron beams, [NSF REU](#)
2016 – present Erik Bigwood – electron and optical interferometry
2016 – present Gino Carrillo – electron and optical interferometry
2016 – present Liz Olson – simulation of electron vortices for JLab Accelerator, [UO Honors Thesis](#)
2015 – present Cody Webb – measurement of geometric phase in electron wavepackets, [NSF SOS Scholar](#)

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- 2015 – present Quin Konyon – simulation and design for holographic optics for electrons, [NSF SOS Scholar](#)
- 2014 – present Simon Swifter – Lorentz TEM and magnetic phase reconstruction
- 2014 – 2015 Sean Hixon – physics of pukao construction on Rapa Nui, [UO Clark Honors Thesis](#)
- 2014 – 2015 Eryn Cangi, Brian Perrett, Michael Womack – design and test of GRIN phase plates, [NASA/Voxtel SBIR subcontract](#)
- 2014 Clara Dunklee – standing waves in Chladni plates and ripple tanks
- 2013 Nathan Wilson – optical and plasmonic angular momentum
- Malia Kawamura (Colby Coll.) – electron Talbot interferometry, [NSF REU](#) & [Colby Honors Thesis](#)
- Oluwatobi Bisola Fatunbi (Lincoln Univ.) – magnetic & antiferromagnetic thin film
- 2012 – 2014 Carly Wright – nanofabrication & optical vortex beams, [LBNL LDRD subcontract](#)
- Alex Schachtner – electron vortex beams, [NSF SOS scholar](#), [LBNL LDRD](#)
- 2012 – 2013 Nick Anthony – computer-generated holography, spatial light modulation
- Jacob Magers – nanofabrication of electron gratings
- 2012 Jonathan Perry-Houts (UC-Berkeley) – magnetic characterization, [LBNL LDRD](#)
- 2009 Aaron Cochran (NIST) – magnetic thin film preparation and SEMPA analysis, [NIST SURF](#)
- 2006 – 2009 Niket Thakkar and John Hess (UA) – optical Lau interferometry, [NASA Space Grant](#)
- 2007 – 2008 Daniel Wanegar (UA) – electron holography, [Honors College grant](#)
- 2006 – 2007 John Hess (UA), applications of optical Lau interferometer
- 2006 Grady Weyenberg (UA), electron beam apparatus construction, [NSF REU](#)
- 2005 – 2006 Mark Robertson-Tessi (UA) – electron Talbot interferometer, [NASA Space Grant](#)

High School Research Advising:

- 2016 – present Asher Tubman (teacher, South Eugene HS) – matter wave interferometry, [Murdoch Partners in Science](#)
- 2016 – present Harjasleen Gulati (student, South Eugene HS) – nanomagnetic domain studies
- 2005 Charles Parks (teacher, Pima Co., AZ HS) – electron microscopy, [NSF RET](#)

Other PhD Committees:

- Chemistry **Institutional Rep. (17):** Matti Alemayehu, Sage Bauers, Pat Campbell, Jeffrey Ditto, Lisa Enman, Chris Funch, Noel Gunning, Erik Hadland, Adam Jansons, Devin Merrill, Dan Moore, Andy Ritenour, Adam Smith, Chris Weber, Richard Westover, Suzannah Wood, Keenan Woods
- Physics **Core Member (6):** Shikha DeFazio, Mohammad (Yasin) Karim, Mark Kuzyk, Kyle Lynch-Klarup, Paul Martin, Charles Warren
- Chairperson (6):** Maira Amezcua, Jason Boucher, Herbert Grotewohl, Brian Hake, Thein Oo, Alex Trevelyan

TEACHING EXPERIENCE

- 2017 Winter **PHYS 290** *Foundations of Physics Lab* – fluids, waves, optics (26 undergrads)
- 2016 Fall **PHYS 290** *Foundations of Physics Lab* – mechanics (51 undergrads)
- PHYS 401** *Undergraduate Research* – (Liz Olson)
- 2016 Spring **PHYS 290** *Foundations of Physics Lab* – electricity, magnetism, circuits (53 undergrads)
- 2016 Winter **PHYS 290** *Foundations of Physics Lab* – fluids, waves, optics (58 undergrads)
- PHYS 401** *Undergraduate Research* – (Simon Swifter)
- 2015 Fall **PHYS 410/510** *Classical Optics* – geometric and physical optics (15 undergrads, 3 grads)
- PHYS 401** *Undergraduate Research* – (Simon Swifter)
- 2015 Summer **PHYS 490** *Intro to Scientific Programming* – co-instructor Rebecka Tumblin (5 undergrads)

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2015 Spring **PHYS 253** *Foundations of Physics I* – calculus-based electricity & magnetism (82 undergrads)
 PHYS 401 *Undergraduate Research* – (Simon Swifter)

2015 Winter **PHYS 252** *Foundations of Physics I* – calculus-based fluids, waves, optics (90 undergrads)
 PHYS 401 *Undergraduate Research* – (Simon Swifter)

2014 Fall **PHYS 251** *Foundations of Physics I* – calculus-based intro mechanics (114 undergrads)
 PHYS 401 *Undergraduate Research* – (Brain Perrett)

2014 Summer **PHYS 490** *Intro to Scientific Programming* – co-instructor Rebecka Tumblin (9 undergrads)

2014 Spring **PHYS 253** *Foundations of Physics I* – calculus-based electricity & magnetism (85 undergrads)
 PHYS 401 *Undergraduate Research* – (Carly Wright, Alex Schachtner)

2014 Winter **PHYS 252** *Foundations of Physics I* – calculus-based fluids, waves, optics (101 undergrads)
 PHYS 607 *Electron Microscopy* – co-instructor Josh Razink (13 grads)
 PHYS 401 *Undergraduate Research* – (Carly Wright)

2013 Fall **PHYS 251** *Foundations of Physics I* – calculus-based intro mechanics (128 undergrads)
 PHYS 607 *Electron Microscopy* – co-instructed with Josh Razink (20 grads)

2013 Spring **PHYS 253** *Foundations of Physics I* – calculus-based electricity & magnetism (93 undergrads)
 PHYS 401 *Undergraduate Research* (Alex Schachtner)

2013 Winter **PHYS 252** *Foundations of Physics I* – calculus-based fluids, waves, optics (123 undergrads)

2012 Fall **PHYS 155** *Physics Behind the Internet* – (50 undergrads)
 PHYS 401 *Undergraduate Research* – (Terra Hardwick, Zach Small)

2012 Winter **PHYS 155** *Physics Behind the Internet* – (72 undergrads)

2011 Fall **PHYS 605** *Modern Optics reading course* – (5 grads)
 PHYS 610 *Intro to Electron Microscopy* – co-instructor Kurt Langworthy, (15 grads)

2003 – 2004 **PHYS 181** *Introductory Physics Laboratory*, University of Arizona (45 undergrads)
 PHYS 251-2 *Introductory Physics Laboratory*, University of Arizona (24 undergrads)

2000 – 2003 **private physics tutor for PH 201-3** – *General Physics*, Corvallis, OR (6 undergrads)

CONTINUING COLLABORATIONS

Sujoy Roy, James Lee, Steve Kevan (LBNL ALS), Sergio Montoya, Eric Fullerton (CMRR UC San Diego) – investigations of magnetic skyrmions in disordered thin films

Peter Ercius, Colin Ophus, Jim Ciston (LBNL NCEM), Martin Linck (CEOS GmbH) – microscopy using structured electrons

Peter Moeck (PSU), Nigel Browning (PNNL) – crystallography with electron vortex beams

Tracy Lovejoy, Niklas Dellby, Ondrej Krivanek (NION Co.), Juan Carlos Idrobo (ORNL CNMS) – STEM with electron vortex beams

PRIOR COLLABORATIONS

Norman Birge, Bill Pratt (Michigan State), Julie Borchers (NIST NCNR) – Magnetic tunnel junctions

Ian Anderson, John Henry Scott, Andy Herzing (NIST) – TEM with electron vortex beams

Amit Agrawal, Henri Lezec (NIST) – Fabrication of diffractive electron optics and plasmonic devices

G. Gallatin, J. McClelland, M. Stiles, J. Unguris (NIST CNST) – Physics of electron optical vortices

M. Niemier, G. Bernstein, W. Porod, X.S. Hu (Notre Dame) – Magnetic cellular automata (MCA) logic

Kai Liu (U.C. Davis) – Patterned Co/Pd multilayers with graded magnetic anisotropy

Yuri Suzuki (U.C. Berkeley) – Magnetization of LaSrMnO₃

M. Tanvir Alam (U.C. Berkeley) – Electric field control of Py and CoFe nanomagnets on BFO substrate

Jacques Miltat (U. Paris-Sud) – Stress-induced anisotropy in NiPd alloy

Carolyn Ross (MIT) – Manipulation of domain walls in exchange-biased permalloy rings

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Manjul Shah (Princeton Instruments), Alice Reinheimer (e2v) – Electron direct detection CCD

TECHNICAL PROFICIENCIES

electron microscopy (SEM, SEMPA, S/TEM)

surface analysis (Auger spectroscopy, X-ray EDS, ion depth profiling, MOKE, Kerr microscopy)

nanofabrication (FIB, e-beam and optical lithography, thermal & e-beam evaporation, sputter deposition)

experimental apparatus (UHV, electron and ion optics and detectors, power and measurement electronics)

mechanical fabrication (machine shop, spot weld, fine electronics assembly)

site evaluation (acoustic transducer, fluxgate magnetometer, spectrum analyzer)

specialized software (Igor Pro, Matlab, Mathematica, LabVIEW, CAD, LaTeX, ImageJ, DigitalMicrograph)

programming languages (C, C++, Visual C++, Visual Basic, Python, PC UI design, FPGA)

formal training in best safety practices for laser, electrical, chemical, machine shop operation