Erik A. Henriksen
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Education

2004 - 2008	Ph.D. in Physics with advisor Prof. Horst Stormer, Columbia University. Thesis titled, "Cyclotron resonance in graphene."
2001 - 2004	Master of Philosophy in Physics and Master of Arts in Physics, Columbia University.
1993 - 1997	Bachelor of Arts in Physics and Asian Studies, Swarthmore College. Thesis titled, "*Niō-zō*: a study of Japanese gate guardians."

Academic Positions

2021 - present	Associate Director for Facilities, Institute of Materials Science & Engineering, Washington University in St. Louis.
2021 - present	Associate Professor, Washington University in St. Louis. Our research program is centered on the physics of atomically thin material systems, in particular correlated physics of graphene and quantum spin liquid physics in transition metal tri-halides and dichalcogenides. The primary tools we employ include high magnetic field and cryogenic measurements of electronic transport, infrared magnetospectroscopy, quantum thermal transport, and also quantum sensing with NV defects in diamond.
2014 - present	Program Faculty member, Institute for Materials Science & Engineering, Washington University.
2013 - 2020	Assistant Professor, Washington University in St. Louis.
2011 - 2013	IQIM Postdoctoral scholar. Electronic transport studies of adatom-decorated graphene devices. With Prof. J. P. Eisenstein & the Institute for Quantum Information and Matter, Caltech.
2009 - 2011	Postdoctoral scholar. Electronic transport and thermodynamic properties of bilayer and trilayer graphene devices, in the laboratory of Prof. J. P. Eisenstein, Caltech Condensed Matter Physics.
2003 - 2008	Graduate research assistant. Electronic transport and high-field magneto-optical absorption of mono- and bilayer graphene devices, and GaN and GaAs two-dimensional heterostructures. Laboratory of Prof. Horst Stormer, Columbia University Dept. of Physics, with work conducted at the National High Magnetic Field Laboratory, Tallahassee, FL.

1997 - 1999	Research technician. Fabrication of nanoscale bolometers with quasi-1D constrictions. Laboratory of Prof. Michael Roukes, Caltech.
1996 - 1997	Research assistant. Magnetic reconnection studies for the Swarthmore Spheromak Experiment with Prof. Michael Brown, Swarthmore College.

Fellowships, Honors, & Awards

2022	Moore Foundation Experimental Physics Investigator
2020	NSF Faculty Early Career Development Program (CAREER)
2007	Charles H. Townes Fellow, Columbia University.
1996 - present	Sigma Xi Scientific Research Society.

Teaching

2021 - present — Associate Professor, Washington University.

Phys 192L, Physics II Laboratory	2022 – present
Phys 192, Physics II	2021
Phys 472, Intro Solid State Physics	2021 – present
Phys 421, Electricity & Magnetism I	2022

2013 - 2020 — Assistant Professor, Washington University.

Phys 422, Electricity & Magnetism II	2019 - 2020
Phys 421, Electricity & Magnetism I	2017 - 2020
Phys 321, Electronics Lab	2013 - 2016
Phys 198, Physics II	2014 - 2017
Phys 584, Computational Methods	2014 - 2017

2014 - 2016	Participant in "Mentoring in STEM Teaching", NSF-funded program at Washington University to develop and strengthen pedagogy of junior faculty.
2012	Visiting Assistant Professor, Harvey Mudd College. Physics 22, Physics Laboratory
2010 - 2012	Substitute for Solid State Physics course (APh 114) and Classical Mechanics and Electromagnetism (Ph 1), Caltech.
2001 - 2008	Private tutor. Taught physics & mathematics to local high school, college, and graduate students.
2006	Designed & taught six-week long introductory physics course emphasizing methods to understand human motion, for the Summer Medical and Dental Education Program, Columbia University Medical School.

2002 - 2004	Designed and taught a one semester course, "Experiments in Atomic and Nuclear Physics" on early quantum physics for the Science Honors Program at Columbia University.
2001 - 2003	Graduate teaching assistant for post-bacc/pre-med physics laboratory course, Columbia University.

University and Department Service

2022	Chair, cluster hire faculty search in quantum sciences associated with the Center for Quantum Leaps. Directed search resulting in hiring a Full Professor theorist, an Associate Professor theorist, and two Assistant Professors, experimentalists in physics.
2021 - present	IMSE Facilities Committee Chair. Oversight of cleanroom operations, equipment purchase and maintenance, strategic planning.
2021	Member, faculty search in Astromaterials, resulting in hire of one Assistant Professor.
2021 - present	Internal NSF CAREER ad hoc reviewer for Research Development Office, OVCR.
2020 - present	Colloquium Committee Chair, Dept. of Physics.
2020 - 2022	University Four-Year Advisor.
2019	Member, faculty search in quantum information and materials, resulting in hire of two Assistant Professors.
2019 - present	Undergraduate Studies Committee member, Dept. of Physics.
2017 - 2020	Major advisor, Dept. of Physics. Mentored 12 students, and represented Physics Dept. at Major-Minor Fair and Orientation activities.
2016 - 2023	Physics Dept. coordinator for Joint Postbaccalaureate Program started by the Office of the Vice Provost for Faculty Affairs and Diversity. As part of enhancing diversity of graduate students, mentored four students admitted to program, one per year.
2014 - 2020	IMSE Facilities Committee member. Assist in oversight of cleanroom operations and equipment purchase and maintenance.
2014 - present	Shop Committee member, Dept. of Physics.

Employment

1999 - 2001	Built and managed cleanroom semiconductor microfabrication facility for joint use by several academic departments, Columbia University.
1997 - 1999	Research technician, Laboratory of Prof. Michael Roukes, Caltech.

Peer-reviewed Publications

(Includes links to download. As of 6.7.23, Google Scholar reports 5329 citations and h-index of 20.)

41. "Isotope Engineering for Spin Defects in van der Waals Materials," Ruotian Gong, Xinyi Du, Eli Janzen, Vincent Liu, Zhongyuan Liu, Guanghui He, Bingtian Ye, Tongcang Li, James H. Edgar, Erik A. Henriksen, Chong Zu, 2023. arxiv

40. "Field and temperature tuning of magnetic diode in permalloy honeycomb lattice," George Yumnam, Moudip Nandi, Pousali Ghosh, Amjed Abdullah, Mahmoud Almasri, Erik Henriksen, Deepak K. Singh. Materials Today Advances **18**, 100386 (2023). Mat. Today Adv. arXiv

39. "Point Defects in Two-Dimensional $RuCl_3$," Wenqi Yang, Linghan Zhu, Yan Lu, Erik Henriksen, Li Yang. Physical Review Materials **7**, 064004 (2023). PRM arXiv

38. "Direct visualization of the charge transfer in Graphene/α-$RuCl_3$ heterostructure," Rossi, Antonio; Dettori, Riccardo; Johnson, Cameron; Balgley, Jesse; Thomas, John; Francaviglia, Luca; Schmid, Andreas; Watanabe, Kenji; Taniguchi, Takashi; Cothrine, Matthew; Mandrus, David; Jozwiak, Chris; Bostwick, Aaron; Henriksen, Erik; Weber-Bargioni, Alexander; Rotenberg, Eli. *Submitted to Nano Letters*. arXiv

37. "Coherent Dynamics of Strongly Interacting Electronic Spin Defects in Hexagonal Boron Nitride," R. Gong, G. He, X. Gao, P. Ju, Z. Liu, B. Ye, E. A. Henriksen, T. Li, C. Zu, Nature Communications **14**, 3299 (2023). N. Comm. arXiv

36. "Arthur Compton & the Mysteries of Light," E. A. Henriksen, Physics Today **75**(11), 44 (2022) PT

35. "Design and optimization of thin-film tungsten (W)-diamond target for multi-pixel X-ray sources," Y. Tan, Qinghao Chen, Shuang Zhou, E. A. Henriksen, Tiezhi Zhang, Medical Physics **49** 5363, (2022). Med. Phys.

34. "Ultrasharp lateral p-n junctions in modulation-doped graphene," J. Balgley, J. Butler, S. Biswas, Z. Ge, S. Lagasse, T. Taniguchi, K. Watanabe, M. Cothrine, D. G. Mandrus, J. Velasco Jr., R. Valentí and E. A. Henriksen, Nano Letters **22**, 4124 (2022). Nano Letters arXiv

33. "Nitrogen Plasma Passivated Niobium Resonators for Superconducting Quantum Circuits," K. Zheng, D. Kowsari, N. J. Thobaben, X. Du, X. Song, S. Ran, E. A. Henriksen, D. S. Wisbey, and K. W. Murch. Appl. Phys. Lett. **120**, 102601 (2022) APL arXiv

32. "Helium surface fluctuations investigated with superconducting coplanar waveguide resonator," N. R. Beysengulov, C. A. Mikolas, J. M. Kitzman, J. R. Lane, D. Edmunds, D. G. Rees, E. A. Henriksen, S. A. Lyon, J. Pollanen, J. Low Temp. Phys. **208**, 482 (2022). JLTP arXiv

31. "Fabrication and surface treatment of electron-beam evaporated niobium for low-loss coplanar waveguide resonators," D. Kowsari, K. Zheng, J. Monroe, N. Thobaben, X. Du, P. Harrington, E. A. Henriksen, D. Wisbey, and K. Murch, Appl. Phys. Lett. **119**, 132601 (2020). APL arXiv

30. "Axion Dark Matter eXperiment: Detailed Design and Operations," ADMX Collaboration, Rev. Sci. Inst. **92**, 124502 (2021). RSI arXiv

29. "Axion Dark Matter eXperiment: Run 1B Analysis Details," ADMX Collaboration, Phys. Rev. D **103**, 032002 (2021). PRD arXiv

28. "Modulation Doping via a Two-Dimensional Atomic Crystalline Acceptor," Y. Wang, J. Balgley, E. Gerber, M. Gray, N. Kumar, X. Lu, J.-Q. Yan, A. Fereidouni, R. Basnet, S. J. Yun, D. Suri, K. Hikari, T. Taniguchi, K. Watanabe, X. Ling, J. Moodera, Y. H. Lee, H. O. H. Churchill, J. Hu, L.

Yang, E.-A. Kim, D. G. Mandrus, E. A. Henriksen, K. S. Burch, Nano Letters **20**, 8446 (2020). Nano Letters arXiv

27. "Broken symmetries and Kohn's theorem in graphene cyclotron resonance," J. Pack, B. J. Russell, Y. Kapoor, J. Balgley, J. Ahlers, T. Taniguchi, K. Watanabe, & E. A. Henriksen, Phys. Rev. X **10**, 041006 (2020). PRX arXiv

26. "An Extended Search for the Invisible Axion with the Axion Dark Matter Experiment", ADMX Collaboration, Phys. Rev. Lett. **124**, 101303 (2020). PRL arXiv

25. "Unexpected hole doping of graphene by osmium adatoms," J. A. Elias & E. A. Henriksen, Annalen der Physik **532**, 1900294 (2020). Annalen der Physik arXiv

24. "Extraordinary magnetoresistance in encapsulated monolayer graphene devices," Bowen Zhou, T. Taniguchi, K. Watanabe, & E. A. Henriksen, Appl. Phys. Lett. **116**, 053102 (2020). APL arXiv

23. "Electronic transport properties of a lithium-decorated $ZrTe_5$ thin film," W. Yu, J. A. Elias, K.-W. Chen, R. Baumbach, T. M. Nenoff, N. A. Modine, W. Pan, & E. A. Henriksen, Scientific Reports **10**, 3537 (2020). SR

22. "Crystal structure reconstruction in the surface monolayer of the quantum spin liquid candidate α-$RuCl_3$," Z. Dai, J.-X. Yu, B. Zhou, S. Tenney, P. Lampen-Kelley, J. Q. Yan, D. Mandrus, E. A. Henriksen, J. Zang, K. Pohl, & J. T. Sadowski, 2D Materials **7**, 035004 (2020). 2D Materials

21. "Optically driven magnetic phase transition of monolayer α-$RuCl_3$," Y. Tian, W. Gao, E. A. Henriksen, J. R. Chelikowsky, & L. Yang, Nano Letters **19**, 7673 (2019). Nano Letters arXiv

20. "Evidence for charge transfer and proximate magnetism in graphene/α-$RuCl_3$ heterostructures," B. Zhou, J. Balgley, P. Lampen-Kelley, J. Q. Yan, D. G. Mandrus, & E. A. Henriksen, Phys. Rev. B **100**, 165426 (2019), *highlighted as Editor's Suggestion*. PRB arXiv

19. "Possible structural transformation and enhanced magnetic fluctuations in exfoliated α-$RuCl_3$," B. Zhou, Y. Wang, G. B. Osterhoudt, P. Kelley, D. Mandrus, R. He, K. S. Burch, & E. A. Henriksen, J. Phys. Chem. Sol. **128**, 291 (2019), *invited focus issue on spin-orbit coupled materials*. JPCS arXiv

18. "Flip-chip gate-tunable acoustoelectric effect in graphene," J. Lane, L. Zhang, M. A. Khasawneh, B. N. Zhou, E. A. Henriksen, & J. Pollanen, J. App. Phys. **124**, 194302 (2018). JAP arXiv

17. "Many-particle physics in the cyclotron resonance of encapsulated monolayer graphene," B. J. Russell, B. Zhou, T. Taniguchi, K. Watanabe, & E. A. Henriksen, Phys. Rev. Lett. **120**, 047401 (2018). PRL arXiv

16. "Electronic transport in tungsten-decorated graphene," J. A. Elias & E. A. Henriksen, Phys. Rev. B **95**, 075405 (2017). PRB arXiv

15. "Transport in indium-decorated graphene," U. Chandni, E. A. Henriksen & J. P. Eisenstein, Phys. Rev. B **91**, 245402 (2015). PRB arXiv

14. "Quantum Hall effect and semimetallic behavior in dual-gated ABA trilayer graphene," E. A. Henriksen, D. Nandi & J. P. Eisenstein, Phys. Rev. X **2**, 011004 (2012). PRX arXiv; *with Commentary*

13. "Measurement of the electronic compressibility of bilayer graphene," E. A. Henriksen & J. P. Eisenstein, Phys. Rev. B **82**, 041412(R) (2010). PRB Rapid arXiv

12. "Interaction-induced shift of the cyclotron resonance of graphene using infrared spectroscopy," E. A. Henriksen, P. Cadden-Zimansky, Z. Jiang, Z. Q. Li, L.-C. Tung, M. E. Schwartz, M. Takita, Y.-J. Wang, P. Kim & H. L. Stormer, Phys. Rev. Lett. **104**, 067404 (2010). PRL arXiv

11. "Optical phonon mixing in bilayer graphene with a broken inversion symmetry," J. Yan, T. Villarson, E. A. Henriksen, P. Kim & A. Pinczuk, Phys. Rev. B **80**, 241417(R) (2009). PRB

10. "Band structure asymmetry of bilayer graphene revealed by infrared spectroscopy," Z. Q. Li, E. A. Henriksen, Z. Jiang, Z. Hao, M. C. Martin, P. Kim, H. L. Stormer & D. N. Basov, Phys. Rev. Lett. **102**, 037403 (2009). PRL arXiv

9. "Observation of anomalous phonon softening in bilayer graphene," J. Yan, E. A. Henriksen, P. Kim & A. Pinczuk, Phys. Rev. Lett. **101**, 136804 (2008). PRL arXiv

8. "Dirac charge dynamics in graphene by infrared spectroscopy," Z. Li, E. A. Henriksen, Z. Jiang, Z. Hao, M. C. Martin, P. Kim, H. L. Stormer & D. N. Basov, Nature Phys. **4**, 532 (2008). Nature Phys arXiv

7. "Cyclotron resonance in bilayer graphene," E. A. Henriksen, Z. Jiang, L.-C. Tung, M. E. Schwartz, M. Takita, Y.-J. Wang, P. Kim & H. L. Stormer, Phys. Rev. Lett. **100**, 087403 (2008). PRL arXiv

6. "Infrared spectroscopy of Landau levels in graphene," Z. Jiang, E. A. Henriksen, L.-C. Tung, Y.-J. Wang, M. E. Schwartz, M. Y. Han, P. Kim & H. L. Stormer, Phys. Rev. Lett. **98**, 197403 (2007). PRL arXiv

5. "Disorder-mediated splitting of the cyclotron resonance line of two-dimensional electron systems," E. A. Henriksen, S. Syed, Y.-J. Wang, H. L. Stormer, L. N. Pfeiffer & K. W. West, Phys. Rev. B **73**, 241309(R) (2006). PRB arXiv

4. "Splitting of the cyclotron resonance in two-dimensional electron systems," E. A. Henriksen, S. Syed, Y.-J. Wang, M. J. Manfra, L. N. Pfeiffer, K. W. West & H. L. Stormer, Physica E **34**, 318 (2006).

3. "Acoustic phonon scattering in a low density, high mobility AlGaN/GaN field effect transistor," E. A. Henriksen, S. Syed, Y. Ahmadian, M. J. Manfra, K. W. Baldwin, A. M. Sergent, R. J. Molnar & H. L. Stormer, Appl. Phys. Lett. **86**, 252108 (2005). APL arXiv

2. "Quantized thermal conductance: measurements in nanostructures," K. Schwab, W. Fon, E. Henriksen, J. M. Worlock & M. L. Roukes, Physica B **280**, 458 (2000).

1. "Measurement of the quantum of thermal conductance," K. C. Schwab, E. A. Henriksen, J. M. Worlock & M. L. Roukes, Nature **404**, 974-977 (2000). Nature, *see also News & Views*.

Contributed Publications (w/o peer review)

2. "Theoretical limits and experimental prospects for structures needed to study new physics," E. Khatami, R. Scalettar, and E. Henriksen, in *2D Quantum Metamaterials*, World Scientific Publishing, 2019. WSP

1. "Digital atomic scale fabrication an inverse Moore's Law – A path to atomically precise manufacturing," J. N. Randall, J. H. G. Owen, E. Fuchs, J. Lake, J. R. Von Ehr, J. Ballard, & E. A. Henriksen, *Micro and Nano Engineering* 1, 1 (2018). MNE

Funding

Period	Source	PI	Award
2022-2027	Moore Foundation Experimental Physics Investigator	Henriksen	$1,250,000

Title & Description: *"Quantum spin liquids in atomically thin materials,"* for developing novel device-based realizations and probes of quantum spin liquid phenomena in atomically thin materials.

2022-2025	ONR FA9550-22-1-0340	Henriksen	$599,748

Title & Description: *"Pursuit of a topological qubit based on thermal transport of Majorana fermions in Kitaev magnets,"* for exploring the physics of thermal transport in α-$RuCl_3$ toward developing the basic functions of a topological qubit.

2022-2027	NSF NRT DGE-2152221	Hayes	$2,998,446

Title & Description: *"Linking Quantum Sensing Technologies across Disciplines: a Convergent Quantum Sciences and Engineering Graduate Training Program,"* to develop new models of graduate education in quantum science, information, and materials.

2020-2025	NSF CAREER-1945278	Henriksen	$849,052

Title & Description: *"Cyclotron resonance spectroscopy of interacting fermions,"* for studies of correlated electron physics in graphene and strongly-correlated materials using infrared magneto-spectroscopy.

2019-2020	NSF QCLI-1936526	Murch	$146,551

Title & Description: *"QLCI–CG: Center for Quantum Sensors."* As co-PI with several other faculty in effort to foster discussion of "quantum sensing" as theme for future QLCI Center grant proposals. No student support: all for organizing workshops, &c.

2018-2021	NSF DMR-1810305	Henriksen	$406,431

Title & Description: *"Pursuit of quantum spin liquids in exfoliated antiferromagnetic insulators."* Sole PI award to study spin liquid and related phenomena in α-$RuCl_3$ with techniques from field of atomically-thin physics.

2018-2019	DARPA STTR D17C-002-0004	Owens	$68,283

Title & Description: *"Atomically precise fabrication and contactless measurement technology."* As co-PI, portion of larger award to Zyvex Labs for developing & characterizing dopant lattices in Si.

2018	Sandia Nat'l Lab Contract 1882025	Henriksen	$30,000

Title & Description: *"Charge doping of $ZrTe_5$ by lithium and potassium adatoms."* One-year student support to study adatom-modified $ZrTe_5$ in collaboration with lab of Dr. Wei Pan, Sandia Labs.

2017-2019 NIH R03 EB024952 Zhang $152,500

Title & Description: *"Development of a Novel W-PG Laminate X-ray Target with Improved Focal Spot Power Density."* As co-PI, collaboratively overseeing a Physics graduate student at WU Medical School.

2017-2018 ARO LC160586 Zhang $152,000

Title & Description: *"Development of Multi-pixel X-ray Source Using Graphene."* As co-PI, collaboratively overseeing a Physics graduate student at WU Medical School.

2016-2019 NSF MRI-1625212 Banerjee $551,800

Title & Description: *"MRI: Acquisition of a direct write laser lithography system."* As co-PI with three other faculty to purchase equipment toward modernizing cleanroom patterning capabilities.

2016 Washington University URSA Henriksen $25,000

Title & Description: *"New Materials from the Forge: Mixing Conductors and Insulators."* Collaboration with Thimsen (Engineering) providing half-year student support to study hafnia & zirconia-modified graphene.

Invited Talks, Colloquia & Seminars

2022

73. "The Compton Effect at 100", Saturday Science, Washington University in St. Louis, St. Louis MO.
72. "Infrared spectroscopy of correlated electrons in graphene", SUNY Stony Brook, NY.
71. "Quantum spin liquids in van der Waals materials", Oregon State University, Corvallis OR.
70. "Pursuing quantum spin liquids in the van der Waals material α-$RuCl_3$", Los Alamos National Laboratory Quantum Materials Working Group, Los Alamos, NM.
69. "Charge-doping the quantum spin liquid candidate α-$RuCl_3$", Indian Institute of Sciences, Bangalore (online).

2021

68. "Cyclotron resonance and p-n junctions in graphene", National Society of Black Physicists, Princeton University, Princeton NJ (online).
67. "Cyclotron resonance spectroscopy of broken symmetry states in graphene", U. Iowa, Iowa City, IA (online).
66. "Mottness and Majoranas in α-$RuCl_3$", UC Santa Cruz, Santa Cruz, CA (online).
65. "A 2d crystalline acceptor: modulation doping in atomically-thin heterostructures", *Transport & Spectroscopy in Two-Dimensional Systems* (online).

64. "Cyclotron resonance spectroscopy in graphene and SmB_6", *Low-Energy Electrodynamics in Solids*-2021 (online).

63. "2d crystalline donors and acceptors: how a quantum spin liquid leads to modulation doping in atomically-thin heterostructures," George Mason University (online).

62. "A 2d crystalline acceptor for modulation doping in van der Waals heterostructures," 2021 MRS Spring Meeting (online).

2020

61. "α-$RuCl_3$ as a 2d crystalline acceptor: modulation doping, p-n junctions, and the pursuit of Veselago's lens," U. Kentucky, Lexington, KY (online).

60. "Cyclotron resonance spectroscopy of broken symmetry states in monolayer graphene," Ohio University, Athens, OH (online).

59. "In pursuit of Hofstadter's butterfly and Veselago's lens," Washington University in St. Louis, St. Louis, MO (online).

58. "Cyclotron resonance spectroscopy of broken symmetry states in graphene," Boston College, Boston, MA (online).

57. "Two takes on graphene: cyclotron resonance & charge-doping a Mott insulator," Ohio State U., Columbus, OH (online).

56. "Toward ultrastrong coupling regime of cavity QED via graphene cyclotron resonance," Columbia University, NY, NY (online).

55. "Cyclotron resonance spectroscopy of broken symmetry states in monolayer graphene," *Cool Electrons in Flatlands 2020*, Catania, Italy (online).

54. "Quantum sensing at Washington University in St. Louis," Brown University, Providence, RI.

53. "Cyclotron resonance spectroscopy of symmetry broken states in monolayer graphene," U. Kentucky, Lexington, KY.

2019

52. "Cyclotron resonance spectroscopy of symmetry broken states in monolayer graphene," Carnegie Mellon, Pittsburgh, PA.

51. "Cyclotron resonance spectroscopy of symmetry broken states in monolayer graphene," U. Michigan, Ann Arbor, MI.

50. "Cyclotron resonance spectroscopy of symmetry broken states in monolayer graphene," Penn State U, State College, PA.

49. "Enhanced conductivity and magnetism in graphene/α-$RuCl_3$ vdW heterostructures," U Missouri, Columbia, MO.

48. "Enhanced conductivity and magnetism in graphene/α-$RuCl_3$ vdW heterostructures," *Quantum Transport in 2D, École des sciences avancées*, Luchon, France.

47. "Electronic transport in graphene/α-$RuCl_3$ vdW heterostructures," CFN Joint Users' Meeting, Brookhaven National Lab, Upton, NY.

46. "Electronic transport in graphene/α-$RuCl_3$ heterostructures," U. Arkansas, Fayetteville, AR.

45. "Atom-thick physics: the progeny of graphene," St. Olaf's College, Northfield, MN.

44. "Electronic transport in graphene/α-$RuCl_3$ heterostructures," Missouri State U., Springfield, MO.

2018

43. "Charge-doping a Mott insulator in graphene heterostructures," U Utah, Salt Lake City, UT.
42. "Charge-doping a Mott insulator in graphene heterostructures," Georgia Tech, Atlanta, GA.
41. "Charge-doping a Mott insulator in graphene heterostructures," Michigan State U, East Lansing, MI.
40. "Two topics in graphene: infrared spectroscopy and charge-doping a Mott insulator," Indiana University, Bloomington, IN.
39. "Proximity effects in graphene/α-$RuCl_3$ heterostructures," *High Magnetic Fields – 23*, Toulouse, France.
38. "Physics by proximity to graphene," Southern Illinois University Carbondale, IL.
37. "Physics by proximity to graphene," Illinois State University Bloomington, Normal, IL.
36. "Physics by proximity to graphene: adatoms and vdW probes," Washington University in St. Louis, St. Louis, MO.

2017

35. "Cyclotron resonance in graphene: Kohn's theorem, many-particle physics, and more," U. Wisconsin Madison, Madison, WI.
34. "Physics by proximity to graphene," U. New Hampshire, Durham, NH.
33. "Electronic and Optical Properties of Single and Few-layer $RuCl_3$," *XXVI International Materials Research Congress*, Cancun, Mexico.
32. "Novel measurement modalities for designer quantum materials," *Future Materials Forum*, UT Knoxville, TN.
31. "Advances in IR magneto-spectroscopy of graphene," *ORNL Workshop on 2D Materials*, Oak Ridge, TN.
30. "Graphene: Particle Physics in Pencil Lead," *Science on Tap Speaker Series*, St. Louis, MO.
29. "Electronic transport in adatom-decorated graphene," McGill University, Montreal, Canada.
28. "Electronic transport in graphene with $5d$-adatoms," TIFR Mumbai, India.

2016

27. "Electronic transport in adatom-decorated graphene," *2D Dirac Materials Beyond Graphene*, U. N. FLorida, Jacksonville, FL.
26. "Electronic transport in adatom-decorated graphene," Texas A&M Univ., College Station, TX.
25. "Electronic transport in adatom-decorated graphene," U. N. Lincoln, Lincoln, NB.
24. "Transport in adatom-decorated graphene," St. Louis University, St. Louis, MO.
23. "Transport in adatom-decorated graphene," Missouri Inst. of Science & Technology, Rolla, MO.

2015

22. "Relativistic electrons in flatland: the case of graphene," *Saturday Science Lecture Series*, Washington University.
21. "Transport in adatom-decorated graphene," Argonne National Laboratory, Lemont, IL.
20. "Transport in adatom-decorated graphene," *Quantum Transport in 2D, École des sciences avancées*, Luchon, France.
19. "Toward new electronic structures in graphene," University of Missouri, St. Louis, St. Louis, MO.

2014

18. "Toward new electronic structures in graphene," Truman State University, Kirksville, MO.
17. "Toward new electronic structures in graphene," IMSE, Washington University, St. Louis, MO.

2013

16. "Experiments with adatoms on graphene," National High Magnetic Field Lab, Tallahassee, FL.
15. "1,2,3 many: electronic structures of layered graphenes," Brown University, Providence, RI.
14. "1,2,3 many: electronic structures of layered graphenes," Washington State U., Pullman, WA.
13. "1,2,3 many: electronic structures of layered graphenes," CSU Fort Collins, CO.
12. "1,2,3 many: electronic structures of layered graphenes," Washington University, St. Louis, MO.

2011

11. "Thick graphene/thin graphite: electronic transport in ABA trilayer graphene," CEQS/IQIM research colloqiuim, Caltech, Pasadena, CA.
10. "Electronic compressibility of bilayer graphene (plus ABA trilayers)," APS March Meeting, Dallas, TX.

2010

9. "Electronic compressibility of bilayer graphene," *High Magnetic Fields – 19*, Fukuoka, Japan.
8. "Electronic compressibility of bilayer graphene," UCSD, San Diego, CA.

2009

7. "Cyclotron resonance in graphene," UCLA, Los Angeles, CA.
6. "Cyclotron resonance in graphene," Caltech, Pasadena, CA.

2008

5. "Cyclotron resonance in graphene," CIFAR Nanoelectronics, Halifax, Nova Scotia, Canada.
4. "Cyclotron resonance in graphene," MIT, Cambridge, MA.
3. "Cyclotron resonance in graphene," Penn State University, State College, PA.
2. "Infrared absorption in graphene," Tokyo University, Tokyo, Japan.

2000

1. "Nanofabrication and the quantum of thermal conductance," Swarthmore College, Swarthmore, PA, 2000.

Contributed Talks & Posters

2022

25. "Charge-doping with, and of, α-$RuCl_3$", Gordon Research Conference on Strongly Correlated Materials, Mt. Holyoke, MA.

2019

24. "Cyclotron resonance spectroscopy of symmetry broken states in monolayer graphene," *Dynamic Dirac Quantum Matter*, U. North Florida, Jacksonville, FL.
23. "Extraordinary magnetoresistance in hBN-encapsulated graphene," APS March Meeting, Boston, MA.
22. "Transport in osmium-decorated graphene," APS March Meeting, Boston, MA.

2018

21. "Magnetic fluctuations in α-$RuCl_3$ seen by proximity to graphene," *Highly Frustrated Magnetism–19*, Davis, CA.

2017

20. "Many-particle physics revealed by cyclotron resonance in graphene," *Electronic Properties of 2D Systems – 22*, Penn State U., State College, PA.
19. "Electronic transport in osmium-decorated graphene," *Future Materials Forum*, UT Knoxville, TN.
18. "Electronic transport signatures of osmium-decorated graphene," *Ohio State Workshop on Spins, Valleys, and Topological States in 2D and Layered Materials*, Columbus, OH.

2016

17. "Transport in adatom-decorated graphene," Gordon Research Conference on *2D Materials Beyond Graphene*, Mount Holyoke College, Mount Holyoke, MA.
16. "Electronic transport in 5d-decorated graphene," *High Magnetic Fields – 22*, Sapporo, Japan.
15. "Electronic transport in tungsten-decorated graphene," *ORNL Workshop on 2D Materials*, Oak Ridge, TN.

2015

14. "Transport in adatom-decorated graphene," Argonne National Laboratory workshop on *2D Materials beyond Graphene: Exploring the Heterostructures*, Lemont, IL.

2014

13. "Transport in In-decorated graphene," *High Magnetic Fields – 21*, Panama Beach City, FL. 2013

12. "Electronic transport experiments on adatom-decorated graphene," APS March Meeting, Baltimore, MD.

2012

11. "Electronic transport in ABA trilayer graphene," APS March Meeting, Boston, MA.

2011

10. "Quantum Hall effect and semimetallic behavior in ABA trilayer graphene," NSPM 2011, Erice, Italy.

2010

9. "Interaction effects in the cyclotron resonance of graphene," High Magnetic Fields-19, Fukuoka, Japan.
8. "Electronic compressibility of bilayer graphene," Graphene Week 2010, U Maryland, MD.
7. "Measurement of the electronic compressibility of bilayer graphene," APS March Meeting, Portland, OR.

pre-2009

6. "Cyclotron resonance in bilayer graphene," APS March Meeting, New Orleans, LA, 2008.
5. "Infrared absorption in graphene," APS March Meeting, Denver, CO, 2007.
4. "Disorder-mediated splitting in the cyclotron resonance of two-dimensional electron systems," EP2DS-16, Albuquerque, NM, 2005.
3. "Acoustic phonon scattering in a gated two-dimensional electron system of an AlGaN/GaN heterostructure," APS March Meeting, Montreal, Quebec, Canada, 2004.
2. "Nanocalorimeter for explorations of mesoscopic heat flow," APS March Meeting, Los Angeles, CA, 1998.
1. "Two-dimensional computer simulations of magnetic reconnection in the Swarthmore spheromak experiment," APS Division of Plasma Physics Meeting, Denver, CO, 1996.

Service to the Profession

Peer Review – Journal submissions

Regular reviewer for articles submitted to Science, Nature Physics, Nature Communications, Physical Review X, Physical Review Letters, Physical Review B, Physical Review Materials, Nano Letters, Applied Physics Letters, European Journal of Physics C, Journal of Applied Physics, ACS Crystal Growth & Design, and ACS Applied Electronic Materials.

Peer Review – Proposals to funding agencies

Panel reviewer for NSF Division of Materials Research, Condensed Matter Physics and Electronic & Photonic Materials.

Ad hoc reviewer for Department of Energy Basic Energy Sciences, Army Research Office, NSF Division of Material Research, The Ohio State University Materials Research Science and Engineering Center.

Proposal reviewer for magnet time at the National High Magnetic Field Laboratory.

Research Summary

Washington University in St. Louis, 2014 to present. Ongoing experiments aim to explore novel and interesting correlated electron phenomena including topological quantum Hall effects and quantum spin liquids, primarily in atomically thin materials.

A dedicated broadband infrared magneto-spectroscopy capability, expressly for investigating atomically-thin crystals with dimensions of < 100 μm, has been developed and is now being used to explore high mobility graphene devices. The first experiments entailed precision measurements of correlated electron effects in graphene, published in PRL; we unambiguously identified signatures of many-particle physics in cyclotron resonance measurements, demonstrating a new approach to the many-body problem as manifested in graphene. More recent work has established many-particle effects in optical detection of broken symmetry states in monolayer graphene, and provided the first optical magneto-spectroscopy view on the unusual quantum Hall octet in high quality dual-gated bilayer graphene samples. In follow-on experiments we will pursue: magneto-spectroscopy of Hofstadter's butterfly and the fractional quantum Hall effect in graphene. We have also started a project on graphene cavity quantum electrodynamics, using the anharmonic Landau level spectrum in graphene as a novel two-level system.

Experiments in a new direction in recent years aim at the stabilization of the quantum spin liquid state in the layered antiferromagnet α-$RuCl_3$ by exfoliating this material to single- or few-layers, and employing van der Waals heterostructure techniques including strain, charge-doping, electric field effect, and moiré patterning to alter and enhance specific magnetic couplings in atomically thin materials. We are the first group to isolate monolayers of this material, and discovered a structural change appearing in only the mono- and bilayer forms. We have explored stacking α-$RuCl_3$ on graphene to use graphene transport as a proximity probe of $RuCl_3$ physics, and discovered a significant charge transfer between graphene and α-$RuCl_3$ when placed in contact, as well as a proximity effect wherein the graphene resistance vs temperature shows non-monotonic excursions in the neighborhood of the α-$RuCl_3$ magnetic critical temperature. We are developing methods to explore spin transport in exotic layered magnets; and also to exploit the charge transfer to create atomically-sharp differentially-doped regions in graphene toward realizing pn-junctions, electron optics, and superlattices created by patterned charge-doping.

New experiments are aimed at developing novel probes of magnetic fluctuations as a means to determine the ground state of quantum magnets including, if not limited to, various potential quantum spin liquid phases. We are developing new capabilities in the lab based around microwave and infrared spectroscopy of NV defects in diamond as the key probes for this work.

For some time we have been interested in the physics of dilute coatings of adatoms on graphene. The primary goal is to introduce a non-negligible spin-orbit coupling into graphene to experimentally realize the prototypical model for a *quantum spin Hall insulator* system. We can controllably deposit most any metallic adatom onto samples of atomically-thin crystals like graphene, at the level of $0.01 - 10\%$ of a monolayer, with simultaneous measurement of electronic transport and thermodynamic (electronic compressibility) properties.

In collaboration with J. Pollanen of MSU, we have made the first successful measurements of graphene using surface acoustic waves; this enables a high frequency probe of physics at finite wavevectors. We plan to pursue measurements in the quantum Hall regime of mono- and bilayer graphene using this technique.

We now collaborate with the Axion Dark Matter Experiment on the development of next generation instrumentation and detectors. In particular we benchmark the behavior of low-noise amplifiers in

the presence of large magnetic fields, and pursue materials development for high quality cavities in a magnetic field.

California Institute of Technology, 2009-2013. Research focused on the unusual and intriguing physics of *graphene*, a single-atom-thick sheet of carbon atoms arranged in a honeycomb lattice. Derived from graphite, single layer graphene as well as its bilayer and trilayer forms exhibit band structures unlike any semiconductor system studied previously. Our experimental work has encompassed thermodynamic measurements in bilayer graphene such as the capacitance, electronic compressibility, and thermoelectric power. We have also explored the electronic transport properties and quantum Hall effect in ABA-stacked trilayer graphene. We extended these studies to high quality, high-mobility large area suspended graphene samples in an effort to access the physics of interacting electrons in graphene; and to the physics of adatom-decorated graphene, having a sub-monolayer coating of a variety of elements.

Columbia University, 2006-2008. We directly measured the Landau level energy spacings in single layer graphene via infrared cyclotron resonance (CR), providing the first optical/AC proof of the relativistic nature of Dirac fermions in a magnetic field B. The resonance energies scale with $\sqrt{B}$ and n_{LL}, the Landau level index. We have performed similar measurements on bilayer graphene, finding the field dependence to vary from nearly linear-in-B to linear-in-$\sqrt{B}$, a consequence of its unique hyperbolic bandstructure. We fabricated large area graphene specimens with a back gate, allowing us to continuously tune the graphene carrier density from holes to electrons. Measurements were carried out at the National High Magnetic Field Lab, where we designed and built two new infrared probes: one for use in superconducting magnets up to B = 18 T, the other for use in high-field resistive magnets up to 31 T. We have demonstrated the feasibility of broadband infrared CR measurements on samples with areas as small as 200 μm^2.

Columbia University, 2003-2006. We have studied an anomalous splitting of the CR line that has been noted in a variety of samples but the origin of which remains unresolved. We fabricated a set of AlGaAs/GaAs quantum wells, with the wells doped by varying amounts of carbon to act as scattering centers. Thus we have samples covering a broad but controlled range of disorder. Additionally, several field-effect transistors were fabricated from this material, allowing control of the carrier density. We have been able to show a clear link between the onset and size of the anomalous CR linesplitting with the degree of disorder in the 2D electron system.

California Institute of Technology, 1997-1999. We designed and fabricated nanoscale suspended calorimeters for measuring heat flow through quasi-1D constrictions. Based on a suspended sheet of SiN, these devices were used to uncover the quantum of thermal conductance, $G_0 = \pi^2 k_B^2 T/(3h)$, for heat flow in one dimension, in a heavily filtered dilution fridge. Additionally a combination Electron Cyclotron Resonance etch / three-head sputter deposition system was designed and built for exploring the effects of surface roughness on Si nanoscale resonators.