James R. Williams

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Experience

University of Maryland, Department of Physics March 2014 – present
Alford Ward Assistant Professor of Physics
Joint Quantum Institute, Fellow
Center for Nanophysics and Advanced Materials, Member

Stanford University July 2009 – March 2014
van Bibber Postdoctoral Fellow *Stanford, CA*

Scientific Highlights
Managed a team pursuing research in three areas in two-dimensional materials where departures from typical free electron metals occur: complex oxide materials, topological insulators and graphene. Some key results to date in these areas are: the development of ionic gating to induced two-dimensional electron liquids (2DEL) at the surface of strontium titanate and observed a gate-tunable Kondo effect; observation unconventional Jopsehson effects in hybrid topological insulators-superconductor devices; creation of graphene-boron nitride heterostructures for the investigation of transport in high-quality graphene devices.

Harvard University September 2003 – June 2009
Graduate Research Fellow, Thesis Advisor: Charles M. Marcus *Cambridge, MA*
Thesis title: Electronic Transport in Graphene: p-n Junctions, Shot Noise, and Nanoribbons

Scientific Highlights
Developed a method to fabricate locally-controlled, electrostatically-gated nanoelectronic graphene devices, creating an interface between electron-like and hole-like excitations (a p-n junction) in a single sheet of graphene. The local electrostatic gate was insulated from the devices by a functionalization layer and an oxide grown by atomic layer deposition. The functionalization layer was needed as the surface of graphene is not catalytically suitable for growth of oxide via atomic layer deposition and was useful because it did not alter the unique electronic properties of graphene. These locally-controlled graphene devices were used to measure transport properties of exotic quantum Hall states where the Dirac-like nature of the elementary excitations in graphene gave rise to new quantized values of conductance that were previous unexpected. Further transport and shot-noise measurements in novel p-n junction geometries were used to elucidate the unique tunneling properties of massless Dirac fermions in graphene.

Education

Harvard Univesrity **September 2003 – June 2009**
Ph.D. and M.S. in Applied Physics

Santa Clara University **September 1998 – June 2002**
B.S. in Engineering Physics

Fellowships and Honors

Karl van Bibber Postdoctoral Fellow in the Dept. of Physics.
Full support for one postdoctoral fellow each year in the Physics Department at Stanford University, given basis of scientific promise measured by the work performed in graduate school.

MIT Pappalardo Postdoctoral Fellowship 2009-2012 Finalist, Alternate.
The mission of the MIT Pappalardo Fellowships in Physics is to sustain a distinguished, on-campus postdoctoral fellowship program for the Department that identifies, recruits and supports the most talented and promising young physicists at an early stage of their careers.

Harvard Graduate Prize Fellowship 2006-2008.
The fellowship supports PhD. students who have demonstrated exceptional research skills in the areas of science and the humanities. This fellowship provides full tuition and 70 percent of the research stipend.

National Science Foundation Graduate Research Fellow 2003-2006.
This national program recognizes and supports outstanding graduate students in the relevant science, technology, engineering, and mathematics disciplines who are pursuing research-based doctoral degrees. The fellowship provides full tuition and research stipend for the three years.

Member of Sigma Pi Sigma Physics Honors Society and Sigma Xi Research Honors Society.

Teaching

Courses taught at University of Maryland: Phys272 (Fields), 3 semesters; Phys731 (Graduate Solid State Physics), 3 semesters; Phys165 (Introduction to Programming for the Physical Sciences) 2 semesters; Phys 404 (Statistical Thermodynamics) 1 semester.

Publications

30. S. Baek, I. Pliskin, and J. R. Williams, **Strong Spin-Orbit Effects in WTe_2 Josephson Junctions**. *Submitting to Physical Review Letters* (2019).

29. F. Yu, S. S. Kalantre, G. Finkelstein, J. R. Williams. **Crisis-Induced Chaotic Behavior of Graphene Josephson Junctions**, *Submitting to PRX* (2019).

28. C. J. Trimble, M. Tso-Wei, N. F. Q. Yuan, S. S. Kalantre, P. Liu, J. J. Cha, L. Fu, and J. R. Williams. **Josephson Detection of Time Reversal Symmetry Breaking $s\pm s'$ Superconductivity in SnTe**, *arXiv:1907.04199*, *Submitted to Science* (2019).

27. P. Liu, J. R. Williams, and J. J. Cha. **Topological Nanomaterials**, *Nat. Rev. Mater.* https://doi.org/10.1038/s41578-019-0113-4 (2019).

26. B. November, J. Sau, J. R. Williams, and J. E. Hoffmann. **Scheme for Majorana Manipulation Using Magnetic Force Microscopy**, *arXiv:1905.09792* (2019).

25. S. Tran, J. Sell, and J. R. Williams. **Dynamical Josephson Effects in Atomically Thin $NbSe_2$**, *arXiv:1903.00543*, *Under review at Nature Physics*, (2019).

24. R. A. Snyder, C. J. Trimble C. C. Rong, P. A. Folkes, P. J. Taylor, J. R. Williams, **Weak-link Josephson Junctions Made from Topological Crystalline Insulators**. *Physical Review Letters* **121**, 097701 (2018).

23. J. R. Williams. ***Electron optics with graphene p-n junctions***. **Two-Dimensional Materials: Properties and Devices**, Cambridge University Press (2017).

22. F. Amet, A. J. Bestwick, J. R. Williams, K. Watanabe, T. Taniguchi, and D. Goldhaber-Gordon. **Composite fermions and broken symmetries in graphene**. *Nature Communications* **6**, 5838 (2015).

21. P. Gallagher, M. Y. Lee, J. R. Williams, and D. Goldhaber-Gordon. **Gate-tunable superconducting weak link and quantum point contact spectroscopy on a strontium titanate surface**. *Nature Physics* **10**, 748 (2014). See *Nature Physics News and Views* doi:10.1038/nphys3098.

20. F. Amet, J. R. Williams, K. Watanabe, T. Taniguchi, and D. Goldhaber-Gordon. **Gate control of spin and valley polarized quantum Hall edge-states in graphene**. *Physical Review Letters* **112**, 196601 (2014).

19. I Sochnikov, A. J. Bestwick, J. R. Williams, T. M. Lippman, I. R. Fisher, D. Goldhaber-Gordon, J. R. Kirtley, and K. A. Moler. **Direct measurement of current-phase relations in superconductor/topological insulator/superconductor junctions**. *Nano Letters* **13**, 3086 (2013).

18. J. R. Williams and D. Goldhaber-Gordon. **Doubling Down on Majorana**. *Nature Physics* **8**, 778 (2012).

17. F. Amet, J. R. Williams, K. Watanabe, T. Taniguchi, and D. Goldhaber-Gordon. **Insulating behavior at the neutrality point in dual-gated, single-layer graphene**. *Physical Review Letters* **110**, 216601 (2013).

16. P. Moetakef, D. G. Ouellette, J. R. Williams, S. J. Allen, L. Balents, D. Goldhaber -Gordon, and S. Stemmer. **Quantum Oscillations from a Two-Dimensional Gas at a Mott/Band Insulator Interface**. *Applied Physics Letters* **101**, 151604 (2012).

15. A. G. F. Garcia, M. Neumann, F. Amet, J. R. Williams, K. Watanabe, T. Taniguchi, and D. Goldhaber-Gordon. **Effective Cleaning of Hexagonal Boron Nitride for Graphene Devices**. *Nano Letters* **12**, 4449 (2012).

14. P. Moetakef†, J. R. Williams†, D. G. Ouellette, A. Kajdos, D. Goldhaber-Gordon S. J. Allen, and S. Stemmer. **Carrier-controlled ferromagnetism in $SrTiO_3$**. *Physical Review X* **2**, 021014 (2012), Editor's Choice in *Science* **337** (2012).

13. J. R. Williams, A. J. Bestwick, P. Gallagher, Seung Sae Hong, Yi Cui, Andrew S. Bleich, J. G. Analytis, I. R. Fisher and D. Goldhaber-Gordon. **Unconventional Josephson Effect in Hybrid Superconductor-Topological Insulator Devices**. *Physical Review Letters* **109**, 056803 (2012), see Physics Vewipoint **5**, 84 (2012).

12. F. Amet, J. R. Williams, A. G. F. Garcia, M. Yankowitz, K. Watanabe, T. Tanaguchi and D. Goldhaber-Gordon. **Tunneling Spectroscopy of Graphene-Boron Nitride Heterostructures**. *Physical Review B* **85**, 073405 (2012).

11. M. Y. Lee†, J. R. Williams†, Sipei Zhang, C. Daniel Frisbie and D. Goldhaber-Gordon. **Electrolyte gate-controlled Kondo effect in $SrTiO_3$**. *Physical Review Letters* **107**, 256601 (2011), see Physics Vewipoint **4**, 106 (2011).

10. J. R. Williams and C. M. Marcus. **Snake States in Graphene p-n Junctions**. *Physical Review Letters* **107**, 046602 (2011).

9. S. Nakaharai, J. R. Williams and C. M. Marcus. **Gate-Defined Graphene Quantum Point Contact in the quantum Hall regime**. *Physical Review Letters* **107**, 036602 (2011).

8. J. R. Williams, Tony Low, M. S. Lundstrom and C. M. Marcus. **Gate-Controlled Guiding of Electrons in Graphene**. *Nature Nanotechnology* **6**, 222 (2011). See accompanying News and Views, *Nature Nanotechnology* **6**, 196 (2011).

7. Judy J. Cha, J. R. Williams, Desheng Kong, Stefan Meister, Hailin Peng, Andrew J. Bestwick, Patrick Gallagher, David Goldhaber-Gordon, and Yi Cui. **Magnetic Doping and Kondo Effect in Bi_2Se_3 Nanoribbons**. *Nano Letters* **10** 1076 (2010).

6. M. C. Lemme, D. C. Bell, J. R. Williams, L. A. Stern, B. W. H. Baugher, P. Jarillo-Herrero, C. M. Marcus, **Etching of Graphene Devices with a Helium Ion Beam**, *ACS Nano* **3** 2674 (2009).

5. D. C. Bell, M. C. Lemme, L. A. Stern, J. R. Williams, C. M. Marcus. **Precision Cutting and Patterning of Graphene with Helium Ions**. *Nanotechnology* **20** 455301 (2009).

4. J. R. Williams, D. A. Abanin, L. DiCarlo, L. S. Levitov and C. M. Marcus. **Quantum Hall Conductance of Two-Terminal Graphene Devices**. *Physical Review B* **80**, 045408 (2009).

3. L. DiCarlo, J. R. Williams, Yiming Zhang, D. T. McClure, C. M. Marcus. **Shot Noise in Graphene**. *Physical Review Letters* **100**, 156801 (2008).

2. J. R. Williams, L. DiCarlo, C. M. Marcus. **Quantum Hall Effect in a Gate-Controlled p-n Junction of Graphene**. *Science* **317**, 638 (2007).

1. B. A. Young, J. R. Williams, S. W. Deiker, S. T. Ruggiero and B. Cabrera. **Using Ion Implantation to adjust Tc in superconducting thin films**. *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment*, **520**, 307 (2004).

Patents

Microfabrication of Carbon-Based Devices Such as Gate-Controlled Graphene
Authors: H. O. H. Churchill, C. M. Marcus and J. R. Williams
Patent No: WO2009132165-A2

Gas Phase Functionalization of Surfaces Including Carbon-based Surface
Authors: Roy G. Gordon, Damon Farmer, C. M. Marcus and J. R. Williams
Application Number 12/157,337

Invited Talks

APS March Meeting 2020, Denver CO
Proximity-induced $s\pm$ Superconnductivity in SnTe.

MRS Spring Meeting - Phoenix, AZ Apr. 2019
Josephson Junctions with Weak Links of Topological Crystalline Insulator Nanowires.

University of Washington Condensed Matter Seminar – Seattle, WA Mar. 2019
Dynamical Josephson Effects in $NbSe_2$.

Appalachian State Physics Department Colloquium – Boone, NC Jan. 2019
Probing Quantum Materials with Josephson Junctions.

Fundamentals of Quantum Materials Winter School – College Park, MD Jan. 2019
Using Josephson Junctions to Probe Quantum Materials.

NYU Condensed Matter Seminar – New York, NY Dec. 2018
Topological Effects in Weak Link Josephson Junctions of Topological Crystalline Insulators.

Rice Center for Quantum Materials – Topological Superconductors Houston, TX Apr. 2018
Josephson Junctions of Topological Crystalline Insulators.

MRS Spring Meeting - Phoenix, AZ Apr. 2018
Manipulation of Majorana Modes in Topological Crystalline Insulators Nanowires.

Duke University Condensed Matter Seminar - Durham, NC Feb. 2018
Josephson Junctions of Topological Crystalline Insulators.

Yale University SSO Seminar - New Haven, CT Nov. 2017
Josephson Junctions of Topological Crystalline Insulators.

Laboratory for Physical Science Seminar - College Park, MD Sept. 2017
Josephson Junctions with weak links of $Pb_xSn_{1-x}Te$.

N.I.S.T. PML Seminar - Gaithersburg, MD Mar. 2017
Possibilities in P-doped Silicon.

Johns Hopkins Condensed Matter Seminar - Baltimore, MD Oct. 2014
Creating Confined Electrons in $SrTiO_3$.

Frontiers in Topological Superconductivity - Hawaii, USA Dec. 2016
Josephson Junctions with weak links of $Pb_xSn_{1-x}Te$.

Majorana Physics in Condensed Matter - Eurice, IT July 2013
New Probes of 3D topological Insulator Josephson Junctions.

M2S Materials and Mechanisms of Superconductivity, Washington DC, July 2012
Seeking Majorana Fermions in Hybrid TI-SC Devices.

Condensed Matter Seminar, University of British Columbia, March 2012
Seeking Majorana Fermions in Hybrid Topological Insulator-Superconductor Devices.

March Meeting 2012, Boston, Massachusetts
Tunable Kondo Effect in $SrTiO_3$.

Emergent Phenomena at Oxide Interfaces, IBM Almaden, Aug. 2011
Guiding A Tunable Kondo Effect in $SrTiO_3$.

Electronic Properties of Graphene 2010, Princeton University, Oct. 2010
Guiding Electrons in Graphene p-n Junctions.

Santa Clara University Physics Dept. Seminar, Oct. 2009
Graphene: device electronics in an atomically-thin conductor.

Graphene Week 2009, Obergurgl Austria, Mar. 2009
Transport Along p-n Junctions in Graphene.

Yale Applied Physics Solid-State and Optics Seminar, Oct. 2008
The Effect of p-n Junctions on Mesoscale Transport in Graphene.

NIST Quantum Electrical Metrology Division Seminar, Oct. 2008
Quantum Transport in Graphene.

Harvard ITAMP Quantum Computation Seminar, Oct. 2008
Quantum Transport in Graphene.

Service and Outreach

GRADMAP Program at UMD
Faculty Advisor. Graduate Resources Advancing Diversity with Maryland Astronomy and Physics (GRAD-MAP) strives to build strong ties with mid-Atlantic minority-serving institutions (MSIs) through seminars, forums, workshops, science discussions, and research. Our goal is to give underrepresented students the skills and experience to successfully pursue graduate degrees in physics and astronomy.

Elected Member – User Committee, National High Magnetic Field Laboraory
The Magnet Lab's Users Committee represents the laboratory's broad multidisciplinary user community and advises the lab's leadership on all issues affecting users of our facilities. Serving 2015-present.