

# 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**

Teaching Fellow appointments at Harvard University for Statistical Physics (Physics 262, Fall 2005) and Superconductivity (Applied Physics 296, Spring 2005).

## **Publications**

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<sup>†</sup>, J. R. Williams<sup>†</sup>, D. G. Ouellette, A. Kajdos, D. Goldhaber-Gordon S. J. Allen, and S. Stemmer. **Carrier-controlled ferromagnetism in SrTiO<sub>3</sub>.** *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 Viewpoint* **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<sup>†</sup>, J. R. Williams<sup>†</sup>, Sipei Zhang, C. Daniel Frisbie and D. Goldhaber-Gordon. **Electrolyte gate-controlled Kondo effect in SrTiO<sub>3</sub>.** *Physical Review Letters* **107**, 256601 (2011), see Physics Viewpoint **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<sub>2</sub>Se<sub>3</sub> 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

Majorana Physics in Condensed Matter - Eurice, IT July 2013

New Probes of 3D topological Insulator Josephson Junctions.

Majorana Zero Modes in Solid State Systems - KITP/UCSB December 2012  
Deconstructing 3D TI 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<sub>3</sub>.

Emergent Phenomena at Oxide Interfaces, IBM Almaden, Aug. 2011  
Guiding A Tunable Kondo Effect in SrTiO<sub>3</sub>.

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 Laboratory**

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.

### **Volunteer at Mission Graduates College Connect Program**

Mission Graduates (<http://www.missiongraduates.org>) is a nonprofit program that aims to increase access of low-income families to programs that help youths reach the goal of attending college. The program engages students from all age groups of students from the Mission District, focusing on students who will be the first to attend college. College education as an end goal is a theme that is woven through all of the academic enrichment programs like College Connect.

### **Santa Clara University Elementary Student Science Outreach Program.**

As president of the Society of Physics Students I designed and started this outreach program which was created to bring demonstrations and activities to local elementary school children to enhance awareness of and interest in science.