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Liang Wu

Affiliation

Department of Physics & Astronomy
University of Pennsylvania

Contact

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Employment

Assistant Professor Department of Physics & Astronomy July 2018 - Present
University of Pennsylvania, Philadelphia, PA, USA
(Leave Of Absence July 2017 - June 2018)

Postdoctoral Fellow Department of Physics January 2016 - June 2018
University of California, Berkeley, CA, USA
Mentor: Joseph W. Orenstein

Graduate Research Assistant Department of Physics & Astronomy June 2011 - October 2015
The Johns Hopkins University, Baltimore, MD, USA
Thesis Adviser: N. Peter Armitage

Education

Ph.D. Physics December 2015
The Johns Hopkins University, Baltimore, MD, USA

M.A. Physics May 2012
The Johns Hopkins University, Baltimore, MD, USA

B.Sc. Physics May 2010
Nanjing University, Nanjing, JiangSu, China
Graduate with Highest Honor

Honors & Awards

- **Forbes 30 Under 30 in Science** 2018
- **Michelson Postdoctoral Prize Lectureship**, Case Reserve Western University, USA
(Named after Albert Michelson, America's 1st Nobel Laureate in science. One junior awardee per year globally in any field of Physics)
Citation: *For his ground-breaking experimental studies of topological materials.* 2017
- **Richard L. Greene Dissertation Award in Experimental Condensed Matter Physics**, American Physical Society
(Two junior awardees per year globally in experimental condensed matter or materials physics)
Citation: *For insightful experiments on the electrodynamic response of topological insulators and the discovery of the topological magneto-electric effect.* 2017
- **Chinese Government Award For Outstanding Self-Financed students Aboard**,
(No more than 500 young, ethnic Chinese PhD students in all fields each year globally) 2016
- **Pacemaker for Outstanding Students**, (10/12,000)
Among all the undergraduate students in Nanjing University, China 2009

- **Highest award in National Mathematical Modeling Competition**, (100/20,000)
Among all the teams in China 2009
- **National Scholarship**, (12/800)
Among all the undergraduate students in Department of Physics, Nanjing University 2008

Publications

† denotes equal contribution. * denotes corresponding author.

Peer-reviewed Journals

18. E. Thewalt, I. M. Hayes, J. P. Hinton, A. Little, S. Patankar, **Liang Wu**, T. Helm, C. Stan, N. Tamura, J. G. Analytis, and J. Orenstein

Imaging anomalous nematic order and strain in optimally doped $BaFe_2(As,P)_2$

Phys. Rev. Lett. **121**, 027001 (2018)

17. R.H. Ireland†, **Liang Wu**†, M. Salehi, N. Koirala, H.E. Katz, S. Oh and N. P. Armitage. *Nonvolatile Solid-State Charged-Polymer Gating of Topological Insulators into the Topological Insulating Regime*

Phys. Rev. Applied **9**, 044003 (2018)

16. T. Higo, H. Man, D. B. Gopman, **Liang Wu**, Y. P. Kabanov, O. M. J. van't Erve, D. Rees, Y. F. Li, S. Patankar, M. Ikhlas, C. L. Chien, R. D. Shull, J. Orenstein, and S. Nakatsuji. *Large magneto-optical Kerr effect and imaging of magnetic octupole domains in an antiferromagnetic metal.*

Nature Photonics **12**, 73-78 (2018)

Highlighted by *Phys.org*, etc.

15. A. Little†, **Liang Wu**†*, P. Kelley, A. Banerjee, S. Patankar, D. Rees, C. A. Bridges, J. Q. Yan, D. Mandrus, S. Nagler and J. Orenstein. *Antiferromagnetic resonance and terahertz continuum in α - $RuCl_3$.*

Phys. Rev. Lett. **119**, 227201 (2017)

14. **Liang Wu***, S. Patankar, T. Morimoto, N. L. Nair, E. Thewalt, A. Little, J. Analytis, J. E. Moore and J. W. Orenstein*. *Giant anisotropic nonlinear optical response in transition metal mononictide Weyl semimetals.*

Nature Physics **13**, 350-355 (2017)

Highlighted by *Phys.org*, etc.

Highlighted in *Department of Energy, Office of Science, Basic Energy Sciences*

13. **Liang Wu***, M. Salehi, N. Koirala, J. Moon, S. Oh and N. P. Armitage*. *Quantized Faraday and Kerr rotation and axion electrodynamics of a 3D topological insulator.*

Science **354**, 1124-1127 (2016)

Highlighted in *Journal Club for Condensed Matter Physics* April 2016

Highlighted by *Phys.org*, etc.

Summary by the editor, “*Shining light on a peculiar coupling*”, *Science*, **354**, 1114 (2016)

Tweeted by Frank Wilczek

Discussed in Frank Wilczek’s colloquium “*Augmenting Reality: Axions, Anyons, and Entangled Histories*” (Available on YouTube)

12. B. Cheng, **Liang Wu**, S. K. Kushwaha, R. J. Cava, and N. P. Armitage *Measurement of the topological surface state optical conductance in bulk-insulating Sn-doped $Bi_{1.1}Sb_{0.9}Te_2S$ single crystals*

Phys. Rev. B. **94**, 201117(R) (2016)

11. M. Brahlek, N. Koirala, M. Salehi, **Liang Wu**, H. D. Lee, C. Xu, M. G. Han, Y. M. Zhu, J. Moon, S. J. Rhee, T. Gustafsson, N. P. Armitage, and S. Oh. *Disorder-driven topological phase*

transition in Bi_2Se_3 thin films.

Phys. Rev. B. 94, 165104 (2016)

10. A. Akrap, M. Hakl, S. Tchoumakov, I. Crassee, J. Kuba, M. O. Goerbig, C. C. Homes, O. Caha, J. Novak, F. Tepe, **Liang Wu**, N. P. Armitage, E. Arushanov, Q. D. Gibson, R. J. Cava, D. van der Marel, C. Faugeras, G. Martinez, M. Potemski, and M. Orlita. *Magneto-optical signature of massless Kane electrons in Cd_3As_2 .*

Phys. Rev. Lett. 117, 136401 (2016) *Editor's suggestion*

Highlighted by the editor of Nature Physics, Nature Physics 12, 992 (2016)

9. **Liang Wu**[†], R. H. Ireland[†], M. Salehi, B. Cheng, N. Koirala, S. Oh, H. E. Katz, and N. P. Armitage. *Tuning and Stabilizing Topological Insulator Bi_2Se_3 in the Intrinsic Regime by Charge Extraction with Organic Overlayers.*

Appl. Phys. Lett. 108, 221603 (2016)

8. Bing Cheng, **Liang Wu**, N. J. Laurita, H. Singh, P. Raychaudhuri and N. P. Armitage. *Anomalous gap edge dissipation in disordered superconductors on the brink of localization.*

Phys. Rev. B. 93, 180511(R) (2016)

7. N. Koirala, M. Brahlek, M. Salehi, **Liang Wu**, J. Dai, J. Waugh, T. Nummy, M. G. Han, Y. Zhu, D. Dasseu, W. D. Wu, N. P. Armitage and S. Oh *Record high mobility topological insulator thin films and dissipation-less quantum Hall effect via temporal interface engineering.*

Nano Letters 15, 8245-8249 (2015).

Highlighted in Best Research of 2015 at the National MagLab

6. **Liang Wu**^{*}, W. K. Tse, M. Brahlek, C. M. Morris, R. Valdés Aguilar, N. Koirala, S. Oh and N. P. Armitage^{*}. *High-resolution Faraday rotation and electron-phonon coupling in surface states of the bulk-insulating topological insulator $Cu_{0.02}Bi_2Se_3$.*

Phys. Rev. Lett. 115, 217602 (2015)

5. M. Salehi, M. Brahlek, N. Koirala, J. Moon, **Liang Wu**, N. P. Armitage and S. Oh. *Stability of low-carrier-density topological-insulator Bi_2Se_3 thin films and effect of capping layers.*

APL Material 3, 091101 (2015). *Invited article*

4. **Liang Wu**, M. Brahlek, R. Valdés Aguilar, A. V. Stier, C. M. Morris, Y. Lubashevsky, L. S. Bilbro, N. Bansal, S. Oh, N. P. Armitage. *A sudden collapse in transport lifetime through the topological phase transition in $(Bi_{1-x}In_x)_2Se_3$.*

Nature Physics 9, 410-414 (2013).

3. R. Valdés Aguilar, **Liang Wu**, A. V. Stier, L. S. Bilbro, N. Bansal, S. Oh, N. P. Armitage. *Aging and reduced bulk conductance in thin films of the topological insulator Bi_2Se_3 .*

J. Appl. Phys. 113, 153702 (2013).

2. J. R. Neilson, A. Llobet, A. V. Stier, **Liang Wu**, J. J. Wen, J. Tao, Y. M. Zhu, Z. B. Tesanovic, N. P. Armitage, T. M. McQueen. *Mixed-Valence-Driven Heavy-Fermion Behavior and Superconductivity in KNi_2Se_2 .*

Phys. Rev. B. 86, 054512 (2012). *Editor's suggestion*

1. R. Valdés Aguilar, A. V. Stier, W. Liu, L. S. Bilbro, D. K. George, N. Bansal, **Liang Wu**, J. Cerne, A. G. Markelz, S. Oh, N. P. Armitage. *Terahertz Response and Colossal Kerr Rotation from the Surface States of the Topological Insulator Bi_2Se_3*

Phys. Rev. Lett. 108, 087403 (2012). *Editor's suggestion*

Highlighted in Department of Energy, Office of Science, Basic Energy Sciences

Manuscripts in review.

3. **Liang Wu**^{*}, A. Little, E. Aldape, D. Rees, P. Kelley, A. Banerjee, D. Mandrus, S. Nagler, E. Altman, J. Orenstein *Field evolution of magnons in α - $RuCl_3$ by high-resolution polarized terahertz*

spectroscopy

arXiv:1806.00855

2. S. Patankar, **Liang Wu**, B. Lu, M. Rai, J. D. Tran, T. Morimoto, D. Parker, A. Grushin, N.L. Nair, J. G. Analytis, J. E. Moore, J. Orenstein, D. H. Torchinsky *Resonance-enhanced optical nonlinearity in the Weyl semimetal TaAs*

arXiv:1804.06973

1. **Liang Wu**^{*}, A. Farid, N. J. Laurita, T. Mueller and N. P. Armitage. *A compact broadband terahertz range quarter-wave plate*

arXiv:1712.08229

Manuscripts in preparation.

3. N. P. Armitage and **Liang Wu**

On the matter of topological insulators as magnetoelectrics

***Journal of Physics: Condensed Matter* (2018) Review article**

2. **Liang Wu**

Linear and nonlinear optical responses in topological materials

***Advances in Physics: X* (2018) Review article**

1. T. Morimoto[†], **Liang Wu**[†], J. E. Moore and J. W. Orenstein.

Nonlinear optical effects on Weyl semi-metals.

***Annual Review of Condensed Matter Physics* (2018) Review article**

Invited Talks

54. **2018 APS MAS meeting, USA**

Giant anisotropic nonlinear optical responses in Weyl semimetals.

2018

53. **Material Science and Engineering Seminar, Drexel University, USA**

Giant anisotropic nonlinear optical responses in Weyl semimetals.

2018

52. **2018 CINT (Center for Integrated Nanotechnologies) user meeting, USA**

Giant anisotropic nonlinear optical responses in Weyl semimetals.

2018

51. **Condensed Matter Seminar, Penn State University, USA**

Giant anisotropic nonlinear optical responses in Weyl semimetals.

2018

50. **International conference on Highly Frustrated Magnetism (HFM 2018), USA**

Antiferromagnetic resonance and terahertz continuum in α -RuCl₃.

2018

49. **International conference on Low Energy Electrodynamics in Solids (LEES 2018),**

Italy

Band geometry and nonlinear optical studies on polar Weyl semimetals.

2018

48. **Condensed Matter Seminar, ENS-Lyon, France**

Antiferromagnetic resonance and terahertz continuum in α -RuCl₃.

2018

47. **Condensed Matter Seminar, Institut Neel, France**

Band geometry and nonlinear optical studies on polar Weyl semimetals.

2018

46. **Condensed Matter Seminar, Oxford University, UK**

Band geometry and nonlinear optical studies on polar Weyl semimetals.

2018

45. **30th Workshop on Recent Developments in Electronic Structure (ES18), USA**

Band geometry and nonlinear optical studies on polar Weyl semimetals.

2018

44. **Condensed Matter Seminar, Oak Ridge National Lab, USA**

Antiferromagnetic resonance and terahertz continuum in α -RuCl₃.

2018

43. **Condensed Matter Seminar, University of Tennessee, USA**

- Band geometry and nonlinear optical studies on polar Weyl semimetals.* 2018
42. **Gordon Berry Moore Foundation 2nd EPIQS Postdoctoral Symposium, USA**
Resonance-enhanced optical nonlinearity in the Weyl semimetal TaAs. 2018
41. **Young Research Leaders Workshop on Topological Matter, Israel**
Resonance-enhanced optical nonlinearity in the Weyl semimetal TaAs. 2018
40. **International conference on Frontier on Electronic Science and Technology, China**
Resonance-enhanced optical nonlinearity in the Weyl semimetal TaAs. 2018
39. **Oxford Symposium on Dynamics and Topology in Quantum Materials, United Kingdom**
Resonance-enhanced optical nonlinearity in the Weyl semimetal TaAs. 2018
38. **Condensed Matter Seminar, Stony Brook University, USA**
Band geometry and nonlinear optical studies on polar Weyl semimetals. 2018
37. **APS March Meeting, USA**
The quantized magnetoelectric effect in topological insulators 2018
36. **Condensed Matter Seminar, Rutgers, The State University of New Jersey, USA**
Band geometry and nonlinear optical studies on polar Weyl semimetals. 2018
35. **ABC...z Seminar, University of California, Santa Barbara, USA**
Band geometry and nonlinear optical studies on polar Weyl semimetals. 2018
34. **SPIE Photonic West, USA**
Giant anisotropic nonlinear optical response in Weyl semimetals. 2018
33. **Center for Nanophysics and Advanced Materials Colloquium, University of Maryland, College Park, USA**
Quantized electro-dynamical response in topological materials. 2017
32. **Condensed Matter Seminar, Johns Hopkins University, USA**
Antiferromagnetic resonance and terahertz continuum in α -RuCl₃. 2017
31. **Physics Colloquium, Case Reserve Western University, USA**
Quantized electro-dynamical response in topological materials. 2017
30. **Michelson Lecture, Case Reserve Western University, USA**
Giant anisotropic nonlinear optical response in Weyl semimetals. 2017
29. **Michelson Lecture, Case Reserve Western University, USA**
Low energy electrodynamics of 3D topological insulator thin films. 2017
28. **Michelson Lecture, Case Reserve Western University, USA**
Antiferromagnetic resonance and terahertz continuum in α -RuCl₃. 2017
27. **The 3rd Conference on Condensed Matter Physics (CCMP 2017), China**
Antiferromagnetic resonance and terahertz continuum in α -RuCl₃. 2017
26. **APS March Meeting Invited Talk for Richard L. Greene Award, USA**
Quantized Faraday and Kerr rotation and axion electrodynamics of a 3D topological insulator. 2017
25. **Physics Colloquium, University of Notre Dame, USA**
Quantized electro-dynamical responses in topological materials. 2017
24. **Gordon Berry Moore Foundation 1st EPIQS Postdoctoral Symposium, USA**
Giant anisotropic nonlinear optical response in transition metal monpnictide Weyl semimetals. 2017
23. **Condensed Matter Seminar, Stanford University, USA**
Shining light on topological insulators and Weyl semimetals. 2017
22. **Condensed Matter Seminar, Boston University, USA**
Shining light on topological insulators and Weyl semimetals. 2017
21. **Condensed Matter Seminar, Michigan State University, USA**
Shining light on topological insulators and Weyl semimetals. 2017

20. **Physics Colloquium, New York University, USA**
Shining light on topological insulators and Weyl semimetals. 2017
19. **Condensed Matter Seminar, University of Pennsylvania, USA**
Shining light on topological insulators and Weyl semimetals. 2017
18. **Condensed Matter Seminar, Princeton University, USA**
Shining light on topological insulators and Weyl semimetals. 2017
17. **Physics Colloquium, Boston College, USA**
Shining light on topological insulators and Weyl semimetals. 2017
16. **Condensed Matter Seminar, Harvard University, USA**
Shining light on topological insulators and Weyl semimetals. 2016
15. **Condensed Matter Seminar, University of Notre Dame, USA**
Shining light on topological insulators and Weyl semimetals. 2016
14. **Material Science Division Forum on Topological Insulators, Lawrence Berkeley National Laboratory, USA**
Quantized Faraday and Kerr rotation and axion electrodynamics of a 3D topological insulator. 2016
13. **290K Condensed Matter Seminar, University of California, Berkeley, USA**
Low-energy electrodynamics of 3D topological insulators. 2016
12. **Condensed Matter Seminar, Perimeter Institute for Theoretical Physics, Canada**
Low energy electrodynamics of 3D topological insulator thin films. 2016
11. **Condensed Matter Seminar, Fudan University, China**
Low energy (Terahertz) electrodynamics of topological insulator thin films. 2015
10. **Energy Materials & Nanotechnology (EMN) Qingdao Meeting, China**
Low energy electrodynamics of topological insulator thin films. 2015
9. **Quantum Materials Seminar, University of California, Berkeley, USA**
Low energy (Terahertz) electrodynamics of topological insulator thin films. 2015
8. **Special Condensed Matter Seminar, Massachusetts Institute of Technology, USA**
Low energy (Terahertz) electrodynamics of topological insulator thin films. 2015
7. **Optical Terahertz Science & Technology Conference, USA**
Low energy electrodynamics of topological insulator thin films. 2015
6. **Condensed Matter Seminar, Nanjing University, China**
How to ‘kill’ a topological insulator (TI) and how to ‘cook’ a bulk-insulating TI? 2014
5. **Low Energy Electrodynamics in Solids conference, France**
A sudden collapse in transport lifetime through the topological phase transition in $(Bi_{1-x}In_x)_2Se_3$. 2014
4. **Correlated Electron Systems, Gordon Research Seminar, USA**
A sudden collapse in transport lifetime through the topological phase transition in $(Bi_{1-x}In_x)_2Se_3$. 2014
3. **Condensed Matter Seminar & ‘Physics in the Field’, the lecture series at the Pulsed Field Facility at Los Alamos National Laboratory, USA**
How to ‘kill’ a topological insulator (TI) and how to ‘cook’ a bulk-insulating TI? 2014
2. **Ultrafast Phenomena in Cooperative Systems, Gordon Research Seminar, USA**
A sudden collapse in transport lifetime through the topological phase transition in $(Bi_{1-x}In_x)_2Se_3$. 2014
1. **Workshop on New Trends in Topological Insulators, Spain**
A sudden collapse in transport lifetime through the topological phase transition in $(Bi_{1-x}In_x)_2Se_3$. 2013

Contributed Talks

7. **APS March Meeting, USA** *Resolving all magnons in antiferromagnetic α -RuCl₃ by time-domain terahertz spectroscopy.* 2018
6. **APS March Meeting, USA** *Giant anisotropic nonlinear optical response in transition metal mononictide Weyl semimetals.* 2017
5. **Quantum Materials Meeting, Lawrence Berkeley National Laboratory, USA** *Giant anisotropic nonlinear optical response in transition metal mononictide Weyl semimetals.* 2016
4. **APS March Meeting, USA** *Quantized Faraday rotation of surface states in 3D topological insulator thin films.* 2016
3. **APS March Meeting, USA** *Cyclotron resonance of surface states in the bulk-insulating topological insulator Bi₂Se₃ by THz spectroscopy.* 2015
2. **APS March Meeting, USA** *Electrodynamics of the topological insulator (Bi_{1-x}In_x)₂Se₃ tuned to the brink of quantum criticality.* 2014
1. **APS March Meeting, USA** *An abrupt change in transport dynamics through topological phase transition in the (Bi_{1-x}In_x)₂Se₃ system.* 2013

Synergistic Activities

- Discussion leader, Topological States of Matter session, Gordon Research Seminar, Developments at the Frontier of Quantum Many-Electron Physics 2016
- Chair, Focus Session: Advances in Topological Materials II, American Physics Society March Meeting 2016 2016
- Referees, *Nature Communications; Science Advances; Physical Review Letters; Physical Review X; Advances in Physics: X; Physical Review B; 2D Materials; Carbon; Scientific Reports; Applied Physics Letters; Europhysics Letters; Superconductor Science and Technology.*

Teaching & Outreach

Teaching Assistant

Department of Physics & Astronomy

- General Physics for science and engineering. Johns Hopkins University
September 2010 – May 2011
- General Physics Lab for engineering majors. September 2010 – May 2011
- Classical Mechanics for Physics majors, head TA. September 2011 – December 2011
- General Physics for Bio-sciences and Premeds. September 2014 – December 2014
- General Physics for science and engineering. January 2015 – May 2015

Outreach Assistant

2011 – 2018

I performed physics demonstration in annual Physics fair for the general public in the Baltimore and Berkeley community.