

Michael W. Ray

Curriculum Vitae

Department of Physics & Astronomy
California State University, Sacramento
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EDUCATION

Ph.D., University of Massachusetts Amherst, Physics, February 2011
Thesis topic: Experiments in Solid ^4He
Thesis adviser: Robert. B. Hallock

M.S., University of Massachusetts Amherst, Physics, May 2005

B.S., The Ohio State University (Columbus), Physics, June 2003

APPOINTMENTS

Assistant Professor, California State University, Sacramento, 2015 – Present

Visiting Assistant Professor, Union College, 2014 – 2015

Post Doctoral Researcher, Amherst College, 2011 – 2014

Post Doctoral Scholar, University of California, Berkeley, 2010 – 2011

Research Assistant, University of Massachusetts Amherst, 2004 – 2010

Teaching Assistant, University of Massachusetts Amherst, 2003 – 2005

Undergraduate Research Assistant, The Ohio State University (Columbus). 2001 – 2003

TEACHING EXPERIENCE

Sacramento State University

- Physics 5B Lab – Laboratory component of General Physics – E&M/modern physics
- Physics 11A – General Physics - Mechanics (calculus based)
- Physics 11A Lab – Laboratory Component of General Physics – Mechanics
- Physics 11C – General Physics – Electricity and Magnetism
- Physics 11C Lab – Laboratory Component of General Physics – Electricity and Magnetism

- Physics 106 – Introduction to Modern Physics
- Physics 115 – Electronics and Instrumentation
- Physics 116 – Advanced Electronics and Instrumentation
- Physics 175 – Advanced Physics Laboratory

Union College

- Physics 120 – Matter in Motion (Mechanics), Winter 2015
- Physics 121 – Principles of Electromagnetism, Fall 2014, Spring 2015
- Physics 300 – Methods of Modern Experimental Physics, Spring 2015

Amherst College

- Superfluidity and Liquid Helium, Interterm 2013

University of Massachusetts Amherst

- Physics Help Room Tutor – Spring 2005
- Physics 134 – Introductory Physics Lab II, Spring 2004
- Physics 153 – General Physics Laboratory I, Fall 2003, Fall 2004

The Ohio State University

- Math Tutor, Fall 2000 – Spring 2002

AWARDS

Kandula Sastry Thesis Award (2013)

University of Massachusetts, Amherst, Physics Department

National Buckeye Scholar (1999-2003)

The Ohio State University (Columbus)

RESEARCH HIGHLIGHTS

New Technique for low temperature pressure measurements: With A. Tadic. Worked to develop new techniques to make pressure measurements within solid samples.

New Technique for temperature measurements: With A. Tadic and D. Johnson. Worked to develop a simple method for automating resistance bridge measurements that can be used to make temperature measurements with resistance thermometers.

Topological structures in BEC: with D.S. Hall. Performed experiments on spinor Bose-Einstein condensates (BEC) to observe novel topological structures including the Dirac monopoles in a synthetic magnetic field, isolated monopoles in the BEC order parameter and knots.

Vortex studies in ultra-cold atomic Bose-Einstein Condensates with D. S. Hall. Performed experiments on small numbers (less than 5) of co-rotating vortices in Bose-Einstein condensates of atomic gasses. This included the study of the vortex nucleation, dynamics, and the angular

momentum of condensates that contain vortices.

High resolution thermometers with R. E. Packard. Built and tested several high resolution thermometers using paramagnetic alloys capable of measuring temperatures to within 10^{-9} K

Fountain effect across solid ^4He with R. B. Hallock. Measured the pressure difference in response to a temperature difference imposed between two reservoirs full of superfluid helium connected by a chamber full of solid helium. The pressure difference was described well by the superfluid fountain effect supporting the existence of a superfluid inside solid helium.

Mass flow through solid ^4He with R. B. Hallock. Observed mass flow through a cell filled with solid ^4He using a novel cell design that allowed for the injection of helium atoms into the solid at pressures greater than the bulk melting pressure of solid helium.

Growth of Solid ^4He from the superfluid with R. B. Hallock. Studied the growth of solid helium crystals at constant temperature. The design of experiment allowed us to continue adding atoms to the solid even after the pressure crossed the bulk melting pressure.

PROFESSIONAL DEVELOPMENT

Center for Teaching and Learning Summer Institute – June 2017, Sacramento State. Workshop on course design, and active learning techniques.

AAPT New Faculty Workshop – November 2016, American Institute of Physics, College Park, MD. Spent four days learning about modern pedagogy, and the latest in physics education research.

ALPhA Laboratory Immersion – May 2016, Miami University of Ohio, Oxford, OH. Spent three days learning how to use the Programmable System on Chip (PSoC) for possible integration into the advanced electronics and instrumentation course (PHY 116) at Sacramento State University

Preparing Future Faculty: Teaching Large Lecture Courses - April 2011, UC Berkeley, Berkeley, CA. Workshop in which faculty from several different departments discussed strategies for teaching large lecture classes.

Machine Shop courses – Summer 2005, University of Massachusetts, Amherst, MA; Fall 2010, UC Berkeley; Summer 2017, Sacramento State. Learned how to use machinists' tools (e.g. lathe, milling machine, etc.) and how to read and create plans to build projects.

Introduction to the C Programming Language – Summer 2002, Ohio Supercomputer Center, Columbus, OH. Learned the basics of programming in C including program structure, I/O, library functions, pointers and structures.

PROFESSIONAL SOCIETIES

American Physical Society – Member

American Physics Society Far West Section – Member

American Association of Physics Teachers – Member

American Association for the Advancement of Science – Member

The Advanced Laboratory Physics Association – Member

GRANTS

- National Science Foundation: DMR-1807476 “RUI: Experimental Study of Dipolar Solid Helium,” \$217,465, 8/2018 – 8/2021
- Sandia Labs Center for Integrated Nanotechnologies. User project 2019AU0024: Fabrication of Microfluidic Channels for Studying Solid Helium-4 2019 -2020.

PUBLICATIONS (includes refereed conference papers)

* Denotes undergraduate researcher

16. A. Tadic*, M.W. Ray, “Development of a Voltage Controlled Resistor for use in a Self-Balancing Resistance Bridge,” Rev. Sci. Inst. **90** 124706 (2019).
15. D.S. Hall, M.W. Ray, K. Tiurev, E. Ruokokoski, A.H. Gheorghe*, M. Möttönen, “Tying quantum knots,” Nature Physics **12**, 478 (2016).
14. M.W. Ray, E. Ruokokoski, K. Tiurev, M. Möttönen and D.S. Hall, “Observation of isolated monopoles in a quantum field,” Science **348**, 544 (2015).
13. M.W. Ray, E. Ruokoski, S. Kandel*, M. Möttönen and D.S. Hall. “Experimental observation of Dirac monopoles. Nature 505, 657 (2014).
12. R. Navarro, R. Carretero-Gonzalez, P.J. Torres, P.G. Kevrekidis, D.J. Frantzeskakis, M.W. Ray, E. Altuntas*, and D.S. Hall. “Dynamics of a few corotating vortices in Bose-Einstein condensates,” Phys. Rev. Lett. 110, 225301 (2013).
11. R.B. Hallock, M.W. Ray and Y. Vekhov, “A summary of mass flux measurements in solid ^4He ,” J. Low Temp. Phys. 169, 264 (2012).
10. M.W. Ray and R.B. Hallock, “Mass flow through solid ^4He induced by the fountain effect ,” Phys. Rev. B 84, 144512 (2011).
9. M.W. Ray and R.B. Hallock, “Mass flux and solid growth in solid ^4He for 60-700 mK,” Phys. Rev. Lett. 105, 145301 (2010).
8. M.W. Ray and R.B. Hallock, “Observation of thermomechanical equilibration in the presence of solid ^4He conduit,” Phys. Rev. B, 82, 012502 (2010).

7. M.W. Ray and R.B. Hallock, “Growth of solid ^4He from the superfluid,” *Phys. Rev. B*, 81, 214532 (2010).
6. M.W. Ray and R.B. Hallock, “Mass flow through solid ^4He ,” *J. Low Temp. Phys.* 158, 560 (2009).
5. M.W. Ray and R.B. Hallock, “Growth of solid ^4He from the superfluid,” *J. Phys.: Conf. Ser.* 150, 032088 (2009).
4. M.W. Ray and R.B. Hallock, “Observation of mass flux through hcp ^4He off the melting curve,” *J. Phys.: Conf. Ser.* 150, 032087 (2009).
3. M.W. Ray and R.B. Hallock, “Observation of mass transport through solid ^4He ,” *Phys. Rev. B*, 79, 224302 (2009).
2. M.W. Ray and R.B. Hallock, “Ray and Hallock Reply:” *Phys. Rev. Lett.* 101, 189602 (2008).
1. M.W. Ray and R.B. Hallock, “Observation of unusual mass transport in solid hcp ^4He ,” *Phys. Rev. Lett.* 100, 235301 (2008).

TALKS

16. “The Tale of Supersolid Helium,” University of Nevada, Reno, April 6, 2018.
15. “The Super World of Superfluids,” California State University, Sonoma, October 30, 2017.
14. “The Super World of Superfluids,” California State University, East Bay, May 19, 2017.
13. “The Super World of Superfluids,” California State University, Chico, March 3, 2017.
12. “Dirac Monopoles in a Bose-Einstein Condensate” Sacramento State University, February 11, 2016.
11. “Dirac Monopoles in a Bose-Einstein Condensate,” UC Davis, September 28, 2015.
10. “The Super World of Superfluids,” Sacramento State University, February 10, 2015.
9. “The Super World of Superfluids,” Bucknell University, February 6, 2015.
8. “The Super Properties of Superfluids, and the Super Materials that Form Them,” Union College, November 4, 2014.
7. “Dirac Monopoles in a Bose-Einstein Condensate,” Union College, May 29, 2014.
6. “Observation of Dirac Monopoles in a Bose-Einstein Condensate,” Hunter College, May 8, 2014.
5. “Breaking Magnets with Bose-Einstein Condensate: Observation and Creation of Synthetic Magnetic Monopoles,” Smith College, April 17, 2014.

4. “Bose-Einstein Condensates: How Do You Make 'em, What Can You Do With 'em,” Bridgewater State University, February 12, 2014.
3. “What Can You Do With a Bose-Einstein Condensate?” Amherst College, November 14, 2013.
2. “Solid Helium and Supersolidity,” Graduate Student Seminar, University of Massachusetts Amherst, June 2, 2010.
1. “Searching for Supersolidity,” Graduate Student Seminar, University of Massachusetts Amherst, February 29, 2008.

CONTRIBUTED PRESENTATIONS

* Denotes undergraduate researcher

19. M.W. Ray, “Dipolar Solid Helium – A New Approach for Quantum Solids,” 2019 Quantum Fluid and Solid Conference.
18. D. Johnson* and M.W. Ray “Investigating LED Stability for Applications in Automated Resistance Measurement Systems,” 2018 Annual Meeting of the APS far West Section
17. A. Tadic* and M.W. Ray, “Development of New Pressure Measuring Technique for Examining Pressure Gradients in Solids,” 2017 Annual Meeting of the APS Far West Section.
16. A. Tadic* and M.W. Ray, “Self Balancing Bridge as a Cryogenic Temperature Measurement System.” 2016 Annual Meeting of the APS Far West Section.
15. M. W. Ray, E. Ruokokoski, K. Tiurev, M. Möttönen, and D.S. Hall, “Isolated Monopoles in a Spinor Bose-Einstein Condensate,” DAMOP 46 (2015).
14. K. Tiurev, E. Ruokokoski, M. Möttönen, M.W. Ray and D.S. Hall, “Creation of topological monopole defects in a quantum field,” ICAP 2014 (presented by E. Ruokokoski).
13. M.W. Ray, E. Ruokokoski, K. Tiurev, M. Möttönen, and D.S. Hall, “Observation of Dirac Monopoles in a synthetic magnetic field,” ICAP 2014 (Presented by E. Ruokokoski, winner of the poster prize).
12. M.W. Ray, E Ruokokoski, K. Tiurev , M. Möttönen and D.S. Hall, “Isolated Monopoles in a Spinor Bose-Einstein Condensate,” DAMOP 45 (2014).
11. M.W. Ray, E. Ruokokoski, S. Kandel*, M. Möttönen and D.S. Hall, “Evidence of Dirac Monopoles in a Spin-1 Bose-Einstein Condensate,” 2014 APS March Meeting
10. M.W. Ray, E. Altuntas*, T. K. Langin* and D.S. Hall, “Nucleation of quantized vortices in an ultracold atomic gas,” DAMOP 44 (2013).
9. M.W. Ray, T.K. Langin* and D.S. Hall, “Vortex formation in a rotating reference frame,” 2013 APS March Meeting.

8. M.W. Ray and D.S. Hall, “Nucleation of vortices in a Bose Einstein condensate,” ICAP 22 (2012).
7. M.W. Ray, E. Altuntas*, T.K. Langin* and D.S. Hall, “Experiments with non-equilibrium co- and counter-circulating vortices,” DAMOP 43 (2012).
6. M.W. Ray and R.B. Hallock, “Growth of solid ^4He from the superfluid,” 2010 APS March Meeting.
5. M.W. Ray and R.B. Hallock, “Mass injection and flow in solid ^4He ,” 2010 APS March Meeting.
4. M.W. Ray and R.B. Hallock, “Mass flow through solid ^4He ,” International Symposium on Quantum Fluids and Solids (2009).
3. M.W. Ray and R.B. Hallock, “Observation of mass flux through solid ^4He ,” 2009 APS March Meeting.
2. M.W. Ray and R.B. Hallock, “Growth of hcp solid ^4He from the superfluid,” 2009 APS March Meeting.
1. W. Tiernan, S. Ionescu*, M.W. Ray and R.B. Hallock, “Measurements of the thermal conductivity of vycor glass filled with superfluid ^4He ,” 2009 APS March Meeting.

SERVICE

Sacramento State Department of Physics and Astronomy

- Budget Committee: Fall 2015 – present
- Assessment Committee: Fall 2015 – present
- Full time, temporary lecturer search committee: Spring 2016
- Lab Safety Committee (chair): Fall 2017 – Present
- Achievement Gap Working Group – Fall 2017
- Tenure Track hiring committee – Fall 2017
- Hiring Committee for Equipment Tech III – Mechanical – January 2017
- Referee for Research and Creative Activity (RCA) award – January 2017
- Safety Committee: Fall 2017 – Present
- Department of Physics Graduate Program Committee: Spring 2018 - Present

College of Natural Science and Mathematics

- Safety Committee: Spring 2018 – Present

University Committees

- General Education Course Review Sub-Committee – Spring 2018

Service to the Community

- Volunteer for AAPT summer meeting workshops – July 2016
- Solar eclipse presentation and viewing activities for second graders at Del Paso Manor

Elementary School – August 2017

- Volunteer for the 2017 solar eclipse viewing party at Sacramento State – August 2017
- Presentern at the Sacramento Expanding your Horizons Conference – October 2017, 2018
- Presented a magnet exploration activity with third graders from Del Paso Manor Elementary School, May 2019.