

# Curriculum Vitae: Michael Riley Brown

Department of Physics and Astronomy

Swarthmore College

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## Current Position

*Morris L. Clothier Professor at Swarthmore College, Past Chair.* Assignments include teaching undergraduate physics at all levels, theory and laboratory: introductory physics, astronomy, classical dynamics and electrodynamics, statistical mechanics, quantum mechanics, plasma physics, mathematical methods, and advanced laboratory. Research interests include magnetic reconnection; particle acceleration, flow, and soft x-ray production from merging magnetofluids; MHD turbulence; magnetothermodynamics; dynamos; self-organization in turbulent systems; magnetic confinement fusion (spheromak and field reversed configuration). (9/94-Present)

## External Support

U. S. Department of Energy Junior Faculty Investigator (9/97-8/00). DOE grant for SSX with collaborators Dr. M. J. Schaffer and Dr. V. S. Lukin (9/00-8/13). NSF/DOE grants with theory collaborator Dr. W. H. Matthaeus (9/98-8/01, 9/01-8/04), Prof. David Schaffner (9/17-8/20). NSF Center for Magnetic Self Organization in Astrophysical and Laboratory Plasmas (9/03-8/14). Continuous funding through DOE and ARPA-E for SSX experiment and simulations. Startup funding from Research Corp, Petroleum Research Fund, NASA, and Swarthmore College (9/94-8/97). Total awards over \$3 M.

## Prior Research Experience

*Senior Research Fellow (6/90-9/94) and Research Fellow (5/89-6/90)* at California Institute of Technology under the supervision of Prof. Paul M. Bellan. Work included the design, construction and operation of a spheromak accelerator for the purposes of tokamak refueling and current drive on the ENCORE tokamak at Caltech and the TEXT tokamak at Univ Texas.

*U. S. Department of Energy Fusion Energy Postdoctoral Research Fellow* at California Institute of Technology (administered through Oak Ridge Associated Universities). Experience included work with high voltage (10 kV), high current (100 kA), rapidly switched discharges for spheromak research. (6/87-5/89)

*Fellowship at Dartmouth College* to study compressible MHD turbulence theory under the supervision of Prof. David C. Montgomery. Theoretical work included the study of density fluctuation spectra and the treatment of compressibility as a small parameter. (7/85-7/86)

## Research Award

*2008 American Physical Society Award for a Faculty Member for Research in an Undergraduate Institution.* Citation: “For his outstanding contributions to plasma physics made possible by his development of a world-class spheromak laboratory at Swarthmore College, and for his energetic mentoring of undergraduate students.”

## Fellowship

*2008 Elected Fellow of the American Physical Society.* Citation: “For experimental studies of magnetic reconnection and for unusual mentoring skills, especially training undergraduates to be skilled researchers in plasma physics.”

## Prior Teaching Experience

*Adjunct Assistant Professor at Occidental College.* Work included teaching undergraduate physics at all levels including modern physics and advanced mechanics. (1/93-9/94)

*Lecturer in Physics at the California Institute of Technology.* Work included teaching a section of introductory physics. (9/92-1/93)

## Education

PhD in Plasma Physics, Dartmouth College, 1987

Dissertation: Experimental investigation of the dynamics of the electron distribution function in a magnetized plasma  $f(v_{\parallel}, v_{\perp})$  under the supervision of Prof. Michael A. Hayes. (9/82-6/87)

Hull Fellow 1985-1986, award based on teaching and research accomplishment.

BA physics, Pomona College, 1981.

## Undergraduate Authors/Honors Students Supervised (27)

C. Geddes (APS Apker winner, Hertz fellow, Rosenbluth thesis award winner), T. Kornack (DOE fellow), W. Luh, J. Lifton, V. Lukin (NSF Fellow, DOE Fellow), D. Auerbach, A. Reighard, T. Gray, D. Schlossberg, M. Landreman (APS Apker finalist, Rhodes Fellow, NSF Fellow), A. Fefferman, A. Falk, A. O Murchadha, J. Fung, V. Chaplin (APS Apker finalist), J. Horwitz, Dan Dandurand (DOE Fellow), Ken Flanagan, Xingyu Zhang, Darren Weinhold, Adrian Wan, Peter Weck, Holden Park, Ariel Rock, Emma Suen-Lewis, Jaron Shrock, Luke Barbano

## PUBLICATIONS

Refereed Journals (63 total)

1. M. Kaur, L. J. Barbano, E. M. Suen-Lewis, J. E. Shrock, A. D. Light, **M. R. Brown**, and D. A. Schaffner, “Measuring equations of state in a relaxed MHD plasma”, *Physical Review E* **97**, 011202 (2018).
2. M. Kaur, L. J. Barbano, E. M. Suen-Lewis, J. E. Shrock, A. D. Light, D. A. Schaffner, **M. R. Brown**, S. Woodruff, and T. Meyer, “Magnetothermodynamics: Measurements of thermodynamic properties in a relaxed magnetohydrodynamic plasma”, *Journal of Plasma Physics* (to appear 2018).
3. **M. R. Brown**, “Literal Sun Jars: Shrinking Stars for Energy Production”, *Scientia*, doi.org/10.26320/SCIENTIA57 (2017)
4. D. A. Schaffner, **M. R. Brown**, and A. Rock, “Possible signatures of dissipation from time-series analysis techniques using a turbulent laboratory MHD plasma”, *Physics of Plasmas*, **23**, 055709 (2016).
5. D. A. Schaffner and **M. R. Brown**, “Multifractal and Monofractal Scaling in a Laboratory Magnetohydrodynamic Turbulence Experiment”, *Astrophysical Journal*, 811:61 (2015).
6. **M. R. Brown**, D. A. Schaffner, and P. J. Weck, “Magnetohydrodynamic Turbulence: Observation and Experiment”, *Physics of Plasmas* **22**, 055601 (2015).
7. P. Weck, D. A. Schaffner, R. Wicks, and **M. R. Brown**, “Permutation Entropy and Statistical Complexity Analysis of Turbulence in Laboratory Plasmas and the Solar Wind”, *Phys. Rev. E* **91**, 023101 (2015).
8. **M. R. Brown** and D. A. Schaffner, “SSX MHD plasma wind tunnel”, *J. Plasma Physics* **81**, 345810302 (2015).
9. **M. R. Brown** and D. A. Schaffner, “Laboratory sources of turbulent plasma: a unique MHD plasma wind tunnel”, *Plasma Sources Science and Technology*, invited review, **23**, 063001 (2014).
10. D. A. Schaffner, **M. R. Brown**, and V. S. Lukin, “Temporal and Spatial Turbulent Spectra of MHD Plasma and an Observation of Variance Anisotropy”. *Astrophysical Journal* **790**, 126 (2014).
11. D. Schaffner, A. Wan, and **M. R. Brown**, “Observation of turbulent intermittency scaling with magnetic helicity in an MHD plasma wind-tunnel”, *Phys. Rev. Letters* **112**, 165001 (2014).
12. D. Schaffner, A. Wan, V. S. Lukin, and **M. R. Brown**, “Turbulence analysis of an experimental flux rope plasma”, *Plasma Physics and Controlled Fusion* **56**, 064003 (2014).

13. T. Gray, **M. R. Brown**, and D. Dandurand, “Observation of a Relaxed Plasma State in a Quasi-Infinite Cylinder”, *Phys. Rev. Letters* **110**, 085002 (2013).
14. **M. R. Brown**, C. D. Cothran, T. Gray, C. E. Myers, and E. V. Belova, “Spectroscopic observation of simultaneous bi-directional reconnection outflows in a laboratory plasma”, *Physics of Plasmas* **19**, 080704 (2012).
15. C. E. Myers, E. V. Belova, **M. R. Brown**, T. Gray, C. D. Cothran, and M. J. Schaffer, “Three-Dimensional MHD Simulations of Counter-Helicity Spheromak Merging in the Swarthmore Spheromak Experiment”, *Physics of Plasmas* **18**, 112512 (2011).
16. X. Zhang, D. Dandurand, T. Gray, **M. R. Brown**, and V. S. Lukin, “Calibrated Cylindrical Mach Probe in a Plasma Wind Tunnel”, *Review of Scientific Instruments* **82**, 033510 (2011).
17. C. D. Cothran, **M. R. Brown**, T. Gray, M. J. Schaffer, and G. Marklin, “Observation of a Helical Self-Organized State in a Compact Toroidal Plasma”, *Phys. Rev. Letters* **103**, 215002 (2009).
18. T. Gray, **M. R. Brown**, C. D. Cothran, M. Schaffer, and G. Marklin, “Stable Spheromak Formation by Merging in an Oblate Flux Conservator”, *Physics of Plasmas* **17**, 032510 (2010).
19. C. D. Cothran, **M. R. Brown**, T. Gray, M. J. Schaffer, and G. Marklin, “Observation of a Non-axisymmetric MHD Self-Organized State”, *Physics of Plasmas* **17**, 055705 (2010).
20. T. Gray, V. S. Lukin, **M. R. Brown**, and C. D. Cothran, “Three-dimensional Reconnection and Relaxation of Merging Spheromak Plasmas”, *Physics of Plasmas* **17**, 102106 (2010).
21. V. H. Chaplin, **M. R. Brown**, D. H. Cohen, T. Gray, and C. D. Cothran, “Spectroscopic Measurements of Temperature and Plasma Impurity Concentration During Magnetic Reconnection at the Swarthmore Spheromak Experiment”, *Physics of Plasmas* **16**, 042505 (2009).
22. **M. R. Brown**, C. D. Cothran, D. Cohen, J. Horwitz, V. Chaplin, “Flow Dynamics and Plasma Heating of Spheromaks in SSX”, *Journal of Fusion Energy* **27**, 16 (2008).
23. **M. R. Brown**, C. D. Cothran, J. Fung, M. J. Schaffer, E. V. Belova, “Novel Dipole Trapped Spheromak Configuration”, *Journal of Fusion Energy* **26**, 31 (2007).

24. C. D. Cothran, J. Fung, **M. R. Brown**, M. J. Schaffer, E. V. Belova, “Spectroscopic Flow and Ion Temperature Studies of a Large s FRC”, *Journal of Fusion Energy* **26**, 37 (2007).
25. Y. Lin, X. Y. Wang, **M. R. Brown**, M. J. Schaffer, and C. D. Cothran, “Modeling Swarthmore Spheromak Reconnection Experiment using Hybrid Code”, *Plasma Physics and Controlled Fusion* **50**, 074012 (2008).
26. **M. R. Brown**, C. D. Cothran, J. Fung, M. Chang, J. Horwitz, M. J. Schaffer, J. Leuer, E. V. Belova, “Dipole Trapped Spheromak in a Prolate Flux Conserver”, *Physics of Plasmas* **13**, 102503 (2006).
27. C. D. Cothran, J. Fung, **M. R. Brown**, and M. J. Schaffer, “Fast, High Resolution Echelle Spectroscopy of a Laboratory Plasma”, *Review of Scientific Instruments* **77**, 063504 (2006).
28. **M. R. Brown**, C. D. Cothran, and J. Fung, “Two Fluid Effects on 3D Reconnection in the SSX Experiment with Comparisons to Space Data”, *Physics of Plasmas* **13**, 056503 (2006).
29. W. H. Matthaeus, C. D. Cothran, M. Landreman, and **M. R. Brown**, “Fluid and Kinetic Structure of Magnetic Merging in the Swarthmore Spheromak Experiment”, *Geophysical Research Letters* **32**, L23104 (2005).
30. C. D. Cothran, M. Landreman, **M. R. Brown**, and W. H. Matthaeus, “Generalized Ohm’s Law in a 3D Reconnection Experiment”, *Geophysical Research Letters* **32**, L03105 (2005).
31. E. V. Belova, R. C. Davidson, H. Ji, M. Yamada, C. D. Cothran, **M. R. Brown**, and M. J. Schaffer, “Numerical Study of the Formation, Ion Spin-up, and Nonlinear Stability Properties of Field Reversed Configurations”, *Nuclear Fusion* **46**, 162 (2006).
32. **M. R. Brown**, C. D. Cothran, M. Landreman, D. Schlossberg, and W. H. Matthaeus, “Experimental Observation of Energetic Ions Accelerated by Three-dimensional Magnetic Reconnection Activity”, *Astrophysical Journal Letters* **577**, L63 (2002).
33. H. Ji, **M. R. Brown**, S. C. Hsu, H. Li, and R. P. Drake “Mini-conference and related sessions on laboratory plasma astrophysics”, *Physics of Plasmas* **11**, 2976 (2004).
34. M. Landreman, C. D. Cothran, **M. R. Brown**, M. Kostora, and J. T. Slough, “Rapid Multiplexed Data Acquisition: Application to Three-dimensional Magnetic Field Measurements in a Turbulent Laboratory Plasma”, *Review of Scientific Instruments* **74**, 2361 (2003).

35. C. D. Cothran, M. Landreman, W. H. Matthaeus, and **M. R. Brown**, “Three Dimensional Structure of Magnetic Reconnection in a Laboratory Plasma”, *Geophysical Research Letters* **30**, 1213 (2003).
36. C. D. Cothran, A. Falk, A. Fefferman, M. Landreman, **M. R. Brown**, and M. J. Schaffer, “Spheromak Merging and Field Reversed Configuration Formation at the Swarthmore Spheromak Experiment”, *Physics of Plasmas* **10**, 1748 (2003).
37. P. Dmitruk, W. H. Matthaeus, N. Seenu, and **M. R. Brown**, “Test Particle Acceleration in Three-dimensional Magnetohydrodynamic Turbulence”, *Astrophysical Journal Letters* **597**, L81 (2003).
38. **M. R. Brown**, C. D. Cothran, M. Landreman, D. Schlossberg, W. H. Matthaeus, G. Qin, V. S. Lukin, and T. Gray, “Energetic Particles from Three-dimensional Magnetic Reconnection Events in SSX”, *Phys. Plasmas* **9**, 2077 (2002).
39. G. Qin, V. S. Lukin, C. D. Cothran, **M. R. Brown**, and W. H. Matthaeus, “Energetic Particles and Magnetohydrodynamic Activity in the Swarthmore Spheromak Experiment”, *Phys. Plasmas* **8**, 4816 (2001).
40. V. S. Lukin, G. Qin, W. H. Matthaeus, and **M. R. Brown**, “Numerical Modeling of Magnetohydrodynamic Activity in the Swarthmore Spheromak Experiment”, *Phys. Plasmas* **8**, 1600 (2001).
41. A. B. Reighard and **M. R. Brown**, “Turbulent Conductivity Measurements in a Spherical Liquid Sodium Flow”, *Phys. Rev. Letters* **86**, 2794 (2001).
42. **M. R. Brown**, “Experimental Studies of Magnetic Reconnection”, *Phys. Plasmas* **6**, 1717 (1999).
43. T. W. Kornack, P. K. Sollins, and **M. R. Brown**, “Experimental Observation of Correlated Magnetic Reconnection and Alfvénic Ion Jets”, *Phys. Rev. E* **58**, R36 (1998).
44. C. G. R. Geddes, T. W. Kornack, and **M. R. Brown**, “Scaling Studies of Spheromak Formation and Equilibrium”, *Phys. Plasmas* **5**, 1027 (1998).
45. **M. R. Brown**, “Experimental Evidence of Rapid Relaxation to Large Scale Structures in Turbulent Fluids: Selective Decay and Maximal Entropy”, *J. Plasma Physics* **57**, 203 (1996).
46. **M. R. Brown** and A. Martin, “Spheromak Experiment using Separate Guns for Formation and Sustainment”, *Fusion Technology* **30**, 300 (1996).

47. P. K. Loewenhardt, **M. R. Brown**, J. Yee, and P. M. Bellan, "Performance Characterization of the Caltech Compact Torus Injector", *Rev. Sci. Instr.* **66**, 1050 (1995).
48. **M. R. Brown** and P. M. Bellan, "Efficiency and Scaling of Current Drive and Refueling by Spheromak Injection into a Tokamak", *N. Fusion* **32**, 1125 (1992).
49. **M. R. Brown** and P. M. Bellan, "Injection of Compact Toroids into Tokamaks for Reactor Refueling", *Plasma Physics and Controlled Nuclear Fusion Research* (Proceedings of the 14th International Conference, Würzburg, Germany, 1992), Vol 3, p. 475, IAEA, Vienna (1993).
50. **M. R. Brown**, T. E. Sheridan, and M. A. Hayes, "Temporal Evolution of the Electron Distribution Function in an Electron Cyclotron Resonant Discharge", *J. Appl. Phys.* **70**, 5306 (1991).
51. **M. R. Brown**, D. M. Cutrer, and P. M. Bellan, "Motion and Equilibrium of a Spheromak in a Toroidal Flux Conserver", *Phys. Fluids B* **3**, 1198 (1991).
52. **M. R. Brown**, A. D. Bailey III, and P. M. Bellan, "Characterization of a Spheromak Plasma Gun: The Effect of Refractory Electrode Coatings", *J. Appl. Phys.* **69**, 6302 (1991).
53. **M. R. Brown**, P. M. Bellan, C. W. Hartman, J. L. Eddleman, M. Gee, J. H. Hammer, B. G. Logan, R. W. Moir, H. S. McLean, A. A. Mirin, A. W. Molvik, W. M. Nevins, W. A. Newcomb, and D. E. Scumaker, "Tokamak Current Drive and Fueling by Compact Torus Injection and Acceleration of Compact Toroids for Other Fusion Applications", *Plasma Physics and Controlled Nuclear Fusion Research* (Proceedings of the 13th International Conference, Washington, D. C., 1990), Vol 3, p. 611, IAEA, Vienna (1991).
54. R. Breun, D. Brouchous, D. Diebold, R. Fonck, N. Hershkowitz, T. Intrator, Y. J. Kim, M. Kishinevsky, W. Li, R. Majeski, J. Pew, P. Probert, E. Y. Wang, Y. Wen, H. Che, M. Doczy, G. McKee, J. Sorensen, T. Tanaka, M. Vukovic, P. Bellan, and **M. R. Brown**, "An RF Heated Tokamak: Phaedrus-T", *Fusion Technology* **19**, 1327 (1991).
55. W. H. Matthaeus, L. Kline, S. Ghosh, and **M. R. Brown**, "Nearly Incompressible Magnetohydrodynamics, Pseudosound and Solar Wind Fluctuations", *J. Geophys. Res.* **96**, A4, 5421 (1991).
56. **M. R. Brown** and P. M. Bellan, "Current Drive by Spheromak Injection into a Tokamak", *Phys. Rev. Letters* **64**, 2144 (1990).

57. **M. R. Brown** and P. M. Bellan, “Spheromak Injection into a Tokamak”, *Phys. Fluids B* **2**, 1306 (1990).
58. K. Siegrist, **M. R. Brown**, and P. M. Bellan, “Simple, Low-Power LaB<sub>6</sub> Cathode”, *Rev. Sci. Instrum.* **60**, 964 (1989).
59. W. H. Matthaeus and **M. R. Brown**, “Nearly Incompressible Magnetohydrodynamics at Low Mach Number”, *Phys. Fluids* **31**, 3634 (1988).
60. D. Montgomery, **M. R. Brown**, and W. H. Matthaeus, “Density Fluctuation Spectra in Magnetohydrodynamic Turbulence”, *J. Geophys. Res.* **92 A1**, 282 (1987).
61. **M. R. Brown**, T.E. Sheridan, and M. A. Hayes, “Re-entrant Cavity as a Low-Power Plasma Source”, *Rev. Sci. Instrum.* **57**, 2957 (1986).
62. M. A. Hayes and **M. R. Brown**, “The Contribution of Cyclotron Heating Induced Spatial Modulation of Electron Magnetization to Tokamak Current Drive”, *Phys. Fluids* **29**, 247 (1986).
63. M. A. Hayes, **M. R. Brown**, M. A. Kasevich, and R. B. McCowan, “Electrostatic Magnetostatic Hybrid Probe for Measuring the Electron Distribution Function in a Magnetized Plasma”, *Rev. Sci. Instrum.* **55**, 928 (1984).

## Manuscripts in Preparation and Current Projects

M. Kaur, L. J. Barbano, E. M. Suen-Lewis, J. E. Shrock, A. D. Light, **M. R. Brown**, and D. A. Schaffner, “Magnetothermodynamics: Measuring equations of state in a relaxed MHD plasma”, submitted to *PRE*.

M. Kaur, L. J. Barbano, E. M. Suen-Lewis, J. E. Shrock, A. D. Light, D. A. Schaffner, **M. R. Brown**, S. Woodruff, and T. Meyer, “Magnetothermodynamics: Measurements of thermodynamic properties and equations of state in a relaxed magnetohydrodynamic plasma”, submitted to *JPP*.

A. Wan, **M. R. Brown**, D. A. Schaffner, V. S. Lukin, and W. H. Matthaeus, “Spatial magnetic correlations functions and Taylor microscale in a turbulent MHD laboratory plasma”.

## Published Conference Proceedings and Abstracts

**M. R. Brown**, P. K. Browning, M. E. Dieckmann, I. Furno, T. P. Intrator, “Microphysics of Cosmic Plasmas: Hierarchies of Plasma Instabilities from MHD to Kinetic”, *Microphysics of Cosmic Plasmas, Space Sciences Series of ISSI*, Volume 47, pp 281-307 (2014).



**M. R. Brown**, C. D. Cothran, D. H. Cohen, J. Horwitz, V. Chaplin, “Three-dimensional Reconnection and Flow Dynamics in the SSX Experiment”, Current Trends in International Fusion Research: A Review Volume 1154, p. 167-176 (2009).

“Magnetic Reconnection in Space and Laboratory Plasmas”, M. Hoshino, R. L. Stenzel, K. Shibata, editors, Magnetic Reconnection 2000, Terra Scientific Publishing Company, Tokyo (2001).

**M. R. Brown**, R. C. Canfield and A. A. Pevtsov, editors, “Magnetic Helicity in Space and Laboratory Plasmas”, American Geophysical Union Chapman Conference, Geophysical Monograph Series #111, (1999).

**M. R. Brown**, Richard Canfield, George Field, Russell Kulsrud, Alexei Pevtsov, Robert Rosner, and Norbert Seehafer, Magnetic Helicity in Space and Laboratory Plasmas: Editorial Summary, “Magnetic Helicity in Space and Laboratory Plasmas”, American Geophysical Union Chapman Conference, Geophysical Monograph Series #111, p. 301, 1999.

**M. R. Brown**, “Spheromak Merging Experiments at SSX: FRC Formation and Spheromak Sustainment”, Physics of High Beta Fusion Plasmas Proceedings, p. 24, 1998.

**M. R. Brown** and P. M. Bellan, “Current Drive by Spheromak Injection into a Tokamak”, Eleventh U.S./Japan Workshop on Compact Toroids Proceedings, p. 206, 1989.

**M. R. Brown** and P. M. Bellan, “Injection of a Spheromak into a Toroidal Flux Conserver”, Ninth U.S. Compact Toroid Symposium Proceedings, p. 84, 1989.

M. A. Hayes, **M. R. Brown**, T. E. Sheridan, R. L. Abraham and M. A. Kasevich, “Current Drive from RF-Induced Modulation of Plasma Magnetization”, AIP Conference Proceedings, No. 129, Radiofrequency Plasma Heating, D. G. Swanson, editor. p. 213, 1985.

50+ abstracts printed in the Bulletin of the American Physical Society since 1983 in association with presentations made at the annual meeting of the American Physical Society Division of Plasma Physics.

10+ abstracts printed in EOS Transactions of the American Geophysical Union since 1986 in association with presentations made at the annual meeting of the American Geophysical Union.

## **Invited Professional Talks and Seminars**

Invited Talk, Joint Space Science Institute, Workshop on Cosmic Accelerators, “Energetic Particles from Reconnection Events and MHD Turbulence in the SSX MHD Wind Tunnel Experiment”, Annapolis, MD, November 2017

Invited Talk, Swarthmore Discussion Group, “Fusion Energy: How to Make a Star on Earth”, Swarthmore, PA, April 2017

Invited Talk, Nonlinear Waves and Chaos Workshop, “MHD Turbulence Measurements in a Laboratory Plasma Wind Tunnel and Comparison to Solar Wind Turbulence”, La Jolla, CA, March 2017

Invited Tutorial Talk, APS-DPP 2014, “Magnetohydrodynamic Turbulence: Observation and Experiment”, New Orleans, October 2014.

Invited Talk, AAPT 2014, “Prospects for Fusion Energy”, Villanova University, March 2014.

IPELS 2013, “Reconnection and turbulence studies in the SSX plasma wind tunnel”, Hakuba, Japan, July 2013.

Invited Talk, Magnetic Reconnection 2012, “Spectroscopic observation of simultaneous bi-directional reconnection outflows in SSX”, Princeton, NJ, May 2012.

Invited Talk, ISSI Workshop on Microphysics of Cosmic Plasmas, “Magnetic Reconnection and Turbulence in an MHD Wind Tunnel”, Bern, Switzerland, April 2012.

Invited Talk, Yosemite Reconnection 2010, “Reconnection-driven ion heating and plasma relaxation in SSX”, Yosemite, CA, February 2010.

Invited Talk, American Physical Society, “Experimental/observational overview: what laboratory can offer to astro- and vice-versa” April Meeting, Washington, DC, February 2010.

Invited Talk, Magnetic Reconnection 2009, “Mass dependent ion heating due to magnetic reconnection in SSX”, Madison, WI, October 2009.

Invited Talk, US/Japan Workshop on Innovative Confinement Concepts based on Self-Organization and Active Control, “Mass dependent ion heating in counter-helicity merging experiments in SSX”, Kusatsu, Japan, September 2009.

IPELS 2009, “Mass dependent ion heating due to magnetic reconnection in the SSX plasma device”, Stockholm, Sweden, June 2009.

Invited Talk, US/Japan Workshop on Magnetic Reconnection 2009, “Ion heating in SSX”, Princeton, NJ, March 2009.

Invited Talk, American Physical Society, “Bidirectional outflow jets in the SSX reconnection experiment”, Prize to a faculty member for research in an undergraduate institution talk, April Meeting, St. Louis, MO, Apr. 2008.

Invited Talk, Magnetic Reconnection 2008, “Outflow jets in the SSX reconnection experiment”, Okinawa, Japan, Mar. 2008.

Invited talk, American Association of Physics Teachers, “Flow and heating dynamics of merging spheromaks in SSX”, Award Winning Research at Undergraduate Institutions, January 2008.

CMSO, “Spheromak Merging and Reconnection in an Oblate Geometry”, Princeton, NJ, July 2008.

Invited talk, New England Space Science Consortium (NESSC), “Outflow jets, ion heating, and 3D structure in the SSX reconnection experiment”, University of New Hampshire, September 2008.

IPELS 2007, “Plasma heating and flow dynamics during 3D reconnection events in the SSX experiment”, Cairns, Australia, August 2007.

Invited Talk, Magnetic Reconnection 2007, “Plasma heating and flow dynamics during 3D reconnection events in SSX”, St. Michaels, MD, Mar. 2007.

Invited Talk, Current Trends in International Fusion Research, “3D reconnection and flow dynamics in the SSX experiment”, Washington, DC, Mar. 2007.

Invited Talk, Innovative Confinement Concepts, “Flow dynamics and heating of spheromaks in SSX”, College Park, MD, Feb. 2007.

Invited Talk, American Geophysical Union, “High velocity plasma jets and 3D magnetic structure in the Swarthmore reconnection experiment”, San Francisco, Dec. 2006.

US/Japan Workshop on Physics of Compact Toroid Plasmas, “Flow dynamics of spheromaks in SSX”, opening talk and conference organizer, Swarthmore College, Nov. 2006.

Invited Talk, Gordon Conference, Physics Research and Education: Electromagnetism, “Undergraduate Plasma Physics Research at the Swarthmore Spheromak Experiment”, Mount Holyoke College, MA, June 2006.

Invited Talk, American Physical Society, “High velocity plasma jets and 3D magnetic structure in the Swarthmore reconnection experiment”, April Meeting, Dallas, TX, Apr. 2006.

Invited Talk, Innovative Confinement Concepts, “Novel Spheromak Configurations”, Austin, TX, Feb. 2006.

Invited Talk, American Physical Society, Division of Plasma Physics, Annual Meeting “Two fluid effects on 3D reconnection in the SSX experiment with comparisons to space data”, Denver, CO, Oct. 2005.

US/Japan Workshop on Physics of Compact Toroid Plasmas, “Novel Spheromak Configurations: Dipole Trapped and  $m=1$  Tilted”, Himeji, Japan, Sept. 2005.

IPELS 2005, “Two fluid effects on reconnection in the SSX experiment”, Tromsø, Norway, July 2005.

Magnetic Reconnection 2005, “Three-dimensional kinetic effects in SSX”, US-Japan Workshop on Magnetic Reconnection, Plasma Merging, and Magnetic Jets, Awajishima Island, Japan, March 2005.

CMSO, “Generalized Ohm’s Law in SSX”, Madison, WI, Aug. 2004.

IPELS 2003, “Three dimensional plasma merging experiments at SSX”, Whitefish, MT, July 2003.

Magnetic Reconnection 2002, 4<sup>th</sup> US-Japan Symposium on Plasma Merging and Magnetic Reconnection, “Three dimensional magnetic reconnection measurements on SSX”, Hakone, Japan, Nov. 2002.

Invited Talk, American Physical Society, Division of Plasma Physics, Annual Meeting, “Energetic Particles from Magnetic Reconnection Events in SSX”, Long Beach, CA, Nov. 2001.

US/Japan Workshop on Physics of Compact Toroid Plasmas, “Overview of SSX-FRC”, Univ. Washington, Feb. 2002.

Innovative Confinement Concepts Workshop, “Overview of the SSX-FRC experiment”, Univ. Maryland, Jan. 2002.

Invited talk, American Association of Physics Teachers, “The role of undergraduate physics research at Swarthmore College”, Philadelphia, PA, Jan.

2002.

IPELS 2001, “Energetic Particles from Magnetic Reconnection Events in SSX”, Niseko, Hokkaido, Japan, July 2001.

Invited talk, US/Japan reconnection workshop, “Energetic Particles from Magnetic Reconnection Events in SSX”, PPPL May 2001,

Varenna 2000, Confinement and Stability of Alternative Fusion Concepts, “Spheromak merging and FRC formation in SSX”, Varenna, Italy, Oct. 2000.

Magnetic Reconnection 2000, Magnetic Reconnection in Space and Laboratory Plasmas, “Three dimensional reconnection studies on SSX: simulation and experiment”, Tokyo, Japan, Feb. 2000.

Presentation to Fusion Energy Sciences Advisory Committee (FESAC), May 1999, on behalf of the University Fusion Association.

Invited Tutorial Talk, American Physical Society, Division of Plasma Physics, Annual Meeting “Magnetic Reconnection Experiments”, New Orleans, LA, Nov. 1998.

Invited Talk, American Geophysical Union, “Correlated Magnetic Reconnection and Alfvénic Ion Jets”, Boston, MA, Apr. 1998.

Invited Talk, Innovative Confinement Concepts Workshop, “Spheromak Merging Experiments at SSX: FRC Formation and Spheromak Sustainment”, Princeton, NJ, Apr. 1998.

Invited Talk, US/Japan Workshop on the Physics of High Beta Fusion Plasmas, “Spheromak Merging Experiments at SSX: FRC Formation and Spheromak Sustainment”, Seattle, WA, Mar. 1998.

Invited Talk, US/Japan Workshop on the Physics of Magnetic Reconnection and Dynamos, “Magnetic Reconnection at SSX”, Princeton, NJ, Jan. 1998.

Invited Talk, Fourth Annual Workshop on the Interrelationship between Plasma Experiments in the Laboratory and in Space IPELS 1997, “Spheromak Formation and Reconnection Studies on SSX”, Maui, Hawaii, June, 1997.

Invited Talk, U.S./Japan Workshop on Helicity Injection Current Drive, “Spheromak Equilibrium and Formation Studies on SSX”, Seattle, WA, Mar. 1997.

Invited Talk, Third Annual Workshop on the Interrelationship between Plasma Experiments in the Laboratory and in Space IPELS 1995, “Experimental Investigation of Reconnection Boundary Layers and Particle Acceleration in Merging Magnetofluids”, Pitlochry, Scotland, July 1995.

Invited Talk, U.S./Japan Workshop on Compact Torus Physics, Seattle, WA, Mar. 1995.

Invited Presentation, International Atomic Energy Agency Conference on Controlled Nuclear Fusion Research, “Injection of Compact Toroids into Tokamaks for Reactor Refueling”, Würzburg, Germany, Oct. 1992.

Invited Presentation, International Atomic Energy Agency Conference on Controlled Nuclear Fusion Research, “Tokamak Current Drive and Fueling

by Compact Torus Injection and Acceleration of Compact Toroids for Other Fusion Applications”, Washington, D.C., Oct. 1990.

Invited Talk, American Physical Society, Division of Plasma Physics, Annual Meeting, “Spheromak Injection into a Tokamak”, Anaheim, CA, Nov. 1989.

**Formal (invited) seminars/colloquia given (over 60 institutions):** Caltech Physics Department Research Conference, Caltech Applied Physics Seminar, Los Alamos National Labs CTR Division Seminar, Lawrence Livermore National Labs MFE Seminar, Oak Ridge National Labs Refueling Symposium, MIT Plasma Fusion Center Seminar (2), Princeton Plasma Physics Lab (3), Naval Research Laboratory, Tri-Alpha Energy, University of Tokyo, University of Illinois, University of Maryland (3), University of New Hampshire (2), University of Wisconsin (3), University of Washington, University of Michigan, University of Iowa (2), Iowa State University, University of Kansas, University of Colorado, Ohio Northern University, Columbia University, University of Delaware (2), West Virginia University (2), Villanova University, University of Texas, Wake Forest University, Auburn University, University of Saskatchewan, Georgia Tech, Dartmouth College (2), Loyola University, Lehigh University, Colgate University, UC Irvine, USC, Cal State LA, Occidental College, Harvey Mudd College, Haverford College, Oberlin College, Grinnell College, Lawrence University (2), Bucknell University, Bowdoin College, Loyola College, Smith College, Franklin and Marshall College, Gettysburg College, Dickinson College, Vassar College, Reed College, St. Olafs College, Hamilton College, Carleton College, College of New Jersey, Trinity College, Franklin Institute, Linda Hall Library (Kansas City, Mo), Philadelphia Racquet Club, Delaware Valley Astronomy Association, Swarthmore Alumni Association (Boston, MA; Houston, TX; Los Angeles, CA), Swarthmore College (3).

## **Professional Societies, Organizations, and Committees**

American Physical Society, member of Division of Plasma Physics Executive Committee (elected, 1998-2001)

University Fusion Association, member of Executive Committee (elected, 1998-2001, 2003-07, 2015-18), Secretary/Treasurer (elected 2004-10). Chair Working Group to Investigate an Improved Model for University Participation on Major Facilities (2016).

National Research Council, Plasma Science Committee (appointed, 2005-10). Chair (nominated by National Academy of Sciences, 2010-12).

Exploratory Plasma Research committee, Chair (2012-), elected, organized EPR 2013 workshop, Fort Worth, TX, Feb 2013. Organized EPR 2014 workshop, Madison, WI, Aug 2014.

American Physical Society Topical Group on Plasma Astrophysics, Executive Committee (elected, 2003-07), chair (elected, 2018-20)

American Physical Society, Division of Plasma Physics Distinguished Lecture Series, speaker (2003-6). Invited talks at Dickinson (3/04), Vas-

sar (11/04), Bucknell (2/05), Reed (2/05), Lawrence (4/05), Loyola (4/05), Kansas (10/05), Ohio Northern (10/05), Colorado (11/05), St. Olafs (11/05), TCNJ (2/06), Trinity (3/06), Iowa State (3/06), Wake Forest (4/06), Auburn (4/06).

National Undergraduate Fellowship Program, Princeton Plasma Physics Laboratory, lecturer (1996-2008)

American Geophysical Union

Council on Undergraduate Research

Sigma Xi

American Physical Society Division of Plasma Physics Program Committee (1999, 2008, 2011, 2015 (subcommittee chair))

National Science Foundation Panel (Plasma Physics) (Feb 1999, Apr 2000, Mar 2002, Mar 2003, Apr 2014, Feb 2018)

Department of Energy Proposal Review Panel (1996, DOE Centers Apr 2004, PECASE Sept. 2017)

Review Committee Physics of Plasmas Journal (AIP, Nov 2007)

International Atomic Energy Agency (IAEA) Paper Selection Committee (2008)

American Physical Society Division of Plasma Physics Science Education Committee (1998-2003)

American Physical Society Division of Plasma Physics Publications Committee (2003-6)

American Physical Society Forum on Education

Washington Fusion Day (congressional visits, 1996-present)

American Physical Society Apker Committee for Undergraduate Physics Thesis (1998-02)

American Physical Society Undergraduate Faculty Award Committee (2008)

NASA Delaware Space Grant Consortium representative (1997-present)

Fusion Energy Sciences Advisory Committee (FESAC) panel member on DOE fusion theory program (2001)

Fusion Energy Sciences Advisory Committee (FESAC) panel member on workforce development (2003)

Fusion Energy Sciences Advisory Committee (FESAC) member of Department of Energy Office of Fusion Energy Sciences visitors committee (2003)

Fusion Energy Sciences Advisory Committee (FESAC) panel member Addressing Policies and Practices Influencing the Dissemination of Research Results (2011)

Fusion Energy Sciences Advisory Committee (FESAC) member Addressing Priorities with the Magnetic Fusion Energy Science Program (2012)

Strategic Directions for US Magnetic Fusion Research, group leader, Austin (Dec 2017).

Center for Magnetic Self Organization (CMSO), General Meeting 2010, conference organizer, Swarthmore College (June, 2010)

Madison Plasma Dynamo Experiment (MPDX) Design Review, chair, with D. Anderson, T. Carter, F. Skiff, P. Titus (December, 2009)

American Physical Society Division of Plasma Physics mini-conference organizer, Laboratory Plasma Astrophysics, (October, 2003)

MR2003 US-Japan Workshop on Magnetic Reconnection, Plasma Merging, and Magnetic Jets, organizing committee (November, 2003)

US/Japan Workshop on Physics of Compact Toroid Plasmas, “The role of flow in compact torus plasmas”, conference organizer, Swarthmore College (Nov. 2006)

CMSO Workshop, Particle Energization in Nature and the Laboratory (Madison, WI), conference organizer (Dec. 2012).

Innovative Confinement Concepts, ICC 2010 (Princeton, NJ), organizing committee (Feb. 2010).

Exploratory Plasma Research, EPR 2013 (Fort Worth, TX), conference organizer and chair (Feb. 2013).

American Physical Society April meeting, special session organizer, Ion heating in turbulent plasmas, Denver, CO (May, 2009)

Rowan College, Department of Physics, external review (November, 2017)

Claremont Colleges Keck Science Program, external review committee (March, 2016)

Loyola University, Department of Physics, external review committee (December, 2003)

University of Texas, Austin, graduate student Career Development Panel (January, 2010)

Oberlin College, Department of Physics, external honors committee (May, 2010)

Dartmouth College, Alumni Advisory Board, physics department review (May 2017)

External member of several PhD, tenure, and promotion review committees (UCLA, Princeton, MIT, Delaware (2), New Mexico, Lawrence)

Swarthmore College Science Center Committee (1999-2001, 2003-), Awards and Fellowship Committee (1996-2008)

Referee for Physical Review Letters, Physical Review, Physics of Plasmas, Journal of Plasma Physics, Nuclear Fusion, Fusion Technology, American Journal of Physics, Review of Scientific Instruments, Plasma Physics and Controlled Fusion