J.R. Sanders

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Education

Ph.D. in Physics. University of Michigan, Ann Arbor, MI. 2016.
Thesis: *Advanced Gravitational Wave Detectors and Detection: Arm Length Stabilization and Directed Searches for Isolated Neutron Stars*. Advisor: Keith Riles.

M.S. in Physics. University of Michigan, Ann Arbor, MI. 2011.

B.A. in Physics and Mathematics. Cum laude. Honors in Physics. Kalamazoo College, Kalamazoo, MI. 2009.

Research Interests

- Gravitational wave detectors and detection
- Hardware development for experimental astrophysics
- Detectability of exotic gravitational wave phenomena
- Multimessenger astronomy

Research Experience

POSTDOCTORAL RESEARCH SCHOLAR, BALLMER GROUP, SYRACUSE UNIVERSITY, SYRACUSE, NY

- **2016 - PRESENT**

  Developing a precision mode-matching system for Advanced LIGO upgrades.

  Investigating novel gravitational wave detector topologies.

  Managing a research laboratory.

GRADUATE STUDENT RESEARCH ASSISTANT, RILES GROUP, UNIVERSITY OF MICHIGAN, ANN ARBOR, MI

- **2011-2015**

  Developed and conducted a search for unidentified pulsars in LIGO S6 data using Fermi-LAT seed positions.

  Developed analysis code for pulsar detection using MATLAB, Perl, and Python.

  Commissioned the aLIGO interferometer as a visiting researcher.

VISITING RESEARCHER, LIGO HANFORD OBSERVATORY, HANFORD, WA

- **JANUARY-MARCH 2014**

  Commissioned the Arm Length Stabilization system for the Y-arm of the LIGO Hanford interferometer, including installation of electronic components, testing and tuning of optical components, alignment to in-vacuum optics, and management of project logistics.

Designed a phase telescope to retrofit optical table designs with a differential wavefront sensing system.

Repaired and characterized legacy hardware for the differential wavefront sensing systems at LHO and LLO.

Tested, modified, installed, and improved an analog phase locking board for the LIGO controls system.

- **MAY - JUNE 2013**

Expanded on previous work from the One-Arm Test as part of the HIFO-Y phase of subsystem commissioning.

- **JUNE - DECEMBER 2012**

Developed a method for real-time measurement of curvature change of aLIGO test masses during heating.

Tested, characterized, and modified the ALS system during the One-Arm Test.

GRADUATE STUDENT RESEARCH ASSISTANT, MCMAHON GROUP, UNIVERSITY OF MICHIGAN, ANN ARBOR, MI

- **2009-2010**

Conducted studies of microwave equipment performance. Analyzed and removed light noise in the QUIET telescope at Llana de Chajnantor Observatory, Atacama, Chile. Studied sensitivity of microwave feedhorns.

REU STUDENT, LIGO HANFORD OBSERVATORY, HANFORD, WA

- **JUNE-AUGUST 2008**

Constructed a prototype feed-forward system for locking noise reduction in aLIGO. Mentored by Dick Gustafson and Daniel Sigg.

- **JUNE-AUGUST 2007**

Surveyed Newtonian noise at LIGO Hanford Observatory and estimated its impact on aLIGO. Mentored by Michael Landry, Fred Raab, and Robert Schofield.

Outreach Experience

PORTAL TO THE PUBLIC FELLOWSHIP, DETROIT ZOOLOGICAL SOCIETY, ROYAL OAK, MI

- **OCTOBER 2014 - OCTOBER 2015**

Participated in a one-year science communication fellowship program.

Developed an interactive exhibit for display at Detroit Zoo science events.

Presented scientific research to a diverse audience.

RELATE WORKSHOP, UNIVERSITY OF MICHIGAN, ANN ARBOR, MI

- **SUMMER 2014**

Participated in a two-month long workshop on lay-audience science communication.

Produced a general-audience video introduction to gravitational waves and LIGO.

Presented a public talk at Arbor Brewing Company as part of the Science By The Pint talk series.

BLOGGER, RACKHAM GRADUATE SCHOOL, UNIVERSITY OF MICHIGAN, ANN ARBOR, MI

- **2011-2012**

Wrote monthly posts on various aspects of graduate school experience for the Student Voices section of the graduate school website.

Teaching Experience

POSTDOCTORAL RESEARCH SCHOLAR, SYRACUSE UNIVERSITY, SYRACUSE, NY

- **2016 - PRESENT**

Advising and mentoring five graduate students.

Directing an undergraduate independent study in gravitational wave experimental techniques.

GRADUATE STUDENT INSTRUCTOR, UNIVERSITY OF MICHIGAN, ANN ARBOR, MI

- **2010 - 2011**

Led four electromagnetism laboratory sections of 20 students each semester. Responsible for writing weekly lectures and evaluating written assignments, including formal laboratory reports. Provided tutoring throughout the year.

- **SEPT - DEC 2009**

Led two mechanics laboratory sections of 20 students. Responsible for writing weekly lectures and pre-lab quizzes, and evaluating written assignments. Provided tutoring throughout the year.

TEACHING ASSISTANT, KALAMAZOO COLLEGE DEPARTMENT OF PHYSICS, KALAMAZOO, MI

- **2006-2009**

Tutored, graded, and supervised laboratory sections for courses in introductory and intermediate mechanics, introductory electromagnetism, and non-majors astronomy.

CONSULTANT, ACADEMIC RESOURCE CENTER, KALAMAZOO COLLEGE, KALAMAZOO, MI

- **2008-2009**

Tutored students in mathematics courses from pre-calculus through linear algebra.

Professional Affiliations

American Physical Society - Division of Astrophysics, Division of Gravitational Physics - member

LIGO-Virgo Collaboration - member

Detroit Zoological Society - Portal to the Public Fellow in Science Communication, 2014 - 2015

Prizes and Awards

2016 Gruber Cosmology Prize

2016 Special Breakthrough Prize in Fundamental Physics

Contributed Publications

Sanders, J.R. and Ballmer, Stefan (2017). *Folding Gravitational-Wave Interferometers.* Class. Quant. Grav. **34,** 025003

Abbott et. al. (2016). *GW150914: The Advanced LIGO Detectors in the Era of First Discoveries.* Phys. Rev. Lett. **116**, 131103

Abbott et. al. (2016). *Observation of Gravitational Waves from a Binary Black Hole Merger.* Phys. Rev. Lett. **116**, 061102

Staley et. al. (2014). *Achieving Resonance in the Advanced LIGO Gravitational-Wave Interferometer.* Class. Quantum Grav. **31** 245010

Posters, Documents, and Presentations

Sanders, J.R. (December 2016). *The Future of Gravitational Wave Interferometers.* Colloquium - Rochester Institute of Technology, Rochester, NY.

Sanders, J.R. (November 2016). *Looking for Black Holes with Lasers!: LIGO Instrument Science*. Presentation - Syracuse University Undergraduate Research Day. Syracuse University, Syracuse, NY.

Sanders, J.R. (August 2016). *Progress on Adaptive Mode Matching*. Presentation - LSC-Virgo Collaboration Meeting. Glasgow, Scotland, UK.

Sanders, J.R. (August 2016). *Folding Gravitational-Wave Interferometers*. Presentation - LSC-Virgo Collaboration Meeting. Glasgow, Scotland, UK.

Sanders, J.R. (April 2016). *Finding Black Holes with Lasers.* Colloquium - Hamilton College, Clinton, NY.

Sanders, J.R. (March 2016). *Adaptive Mode Matching for Advanced LIGO Upgrades*. Presentation - LSC-Virgo Collaboration Meeting. Pasadena, CA.

Maganas-Sandoval, F. et. al. (March 2016). *Adaptive mode matching for A+*. Poster - LSC-Virgo Collaboration Meeting. Pasadena, CA.

Sanders, J.R. (April 2015). *Towards Multimessenger Pulsar Astronomy: Searching for Fermi Pulsars in LIGO Data.* Presentation - American Physical Society April Meeting. Baltimore, MD.

Sanders, J.R. (March 2015). *Update: A Directed Search of Fermi-LAT Unassociated Sources in LIGO Data*. Presentation - LSC-Virgo Collaboration Meeting. Pasadena, CA.

Sanders, J.R. (March 2015). *Why Do We Give Talks?: The Art and Science of Effective Presentations*. Presentation - LSC-Virgo Collaboration Meeting. Pasadena, CA.

Sanders, J.R. (January 2015). *Towards Multimessenger Pulsar Astronomy: Searching for Fermi Pulsars in LIGO Data*. Colloquium - California Institute of Technology, Pasadena, CA

Sanders, J.R. (November 2014). *Locking the Advanced LIGO Interferometer.* Colloquium - Kalamazoo College, Kalamazoo, MI

Sanders, J.R. (November 2014). *A Directed Search of Fermi-LAT Unassociated Sources in LIGO Data*. Presentation - 24th Midwest Relativity Meeting. Oakland University, Rochester, MI

Sanders, J.R. (November 2014). *Listening to Spacetime with LIGO.* Colloquium - Grand Valley State University, Grand Rapids, MI

Sanders, J.R. (October 2014). *Locking the Advanced LIGO Interferometer*. Colloquium - University of Wisconsin - Milwaukee, Milwaukee, WI.

Sanders, J.R. (September 2014). *LIGO: Listening to Black Holes with Lasers*. Outreach talk - Science By The Pint, Arbor Brewing Company, Ann Arbor, MI.

Sanders, J.R. (August 2014). *GammaSearch: A Directed Search of Fermi-LAT Unassociated Sources*. Presentation - LSC-Virgo Collaboration Meeting. LIGO-G1401301.

Sanders, J.R. (March 2013). *How to Measure Spacetime: The Emerging Field of Gravitational Wave Interferometry*. Colloquium - Albion College, Albion, MI.

Sanders, J.R. (January, 2009). *Newtonian Noise and Advanced LIGO*. Presentation - 2nd Annual Midwest Conference for Undergraduate Women in Physics at University of Illinois.

Sanders, J.R. (January 2009). *Fiber-optic stabilization for Advanced LIGO.* Poster - 2nd Annual Midwest Conference for Undergraduate Women in Physics at University of Illinois.

Sanders, J.R. (2008) *Preliminary Optical Fiber Stabilization for AdvLIGO Pre-Lock Acquisition System.* LIGO-T080352.

LSC-Virgo Publications

As an active member of the LIGO Scientific Collaboration, the following publications are those for which I hold authorship rights.

Abbott et. al. (2016). *The basic physics of the binary black hole merger GW150914.* Annalen Phys.

Abbott et. al. (2016). *Binary Black Hole Mergers in the first Advanced LIGO Observing Run.* Phys. Rev. X **6**, 041015

Abbott et. al. (2016). *GW151226: Observation of Gravitational Waves from a 22-Solar-Mass Binary Black Hole Coalescence.* Phys. Rev. Lett. **116**, 241103

Abbott et. al. (2016). *A First Targeted Search for Gravitational-Wave Bursts from Core-Collapse Supernovae in Data of First-Generation Laser Interferometer Detectors.* arXiv:1605.01785

Abbott et. al. (2016). *Comprehensive All-sky Search for Periodic Gravitational Waves in the Sixth Science Run LIGO Data.* arXiv:1605.03233

Abbott et. al. (2016). *Search for transient gravitational waves in coincidence with short duration radio transients during 2007-2013.* arXiv:1605.01707

Abbott et. al. (2016). *Localization and broadband follow-up of the gravitational-wave transient GW150914.* arXiv:1602.08492

Adrián-Martínez et. al. (2016). *High-energy Neutrino follow-up search of Gravitational Wave Event GW150914 with ANTARES and IceCube*. arXiv:1602.05411

Abbott et. al. (2016). *GW150914: Implications for the stochastic gravitational wave background from binary black holes*. arXiv:1602.03847

Abbott et. al. (2016). *Astrophysical Implications of the Binary Black-Hole Merger GW150914*. arXiv: 1602.03846

Abbott et. al. (2016). *Calibration of the Advanced LIGO detectors for the discovery of the binary black-hole merger GW150914*. arXiv:1602.03845

Abbott et. al. (2016). *Characterization of transient noise in Advanced LIGO relevant to gravitational wave signal GW150914.* arXiv:1602.03844

Abbott et. al. (2016). *The Rate of Binary Black Hole Mergers Inferred from Advanced LIGO Observations Surrounding GW150914*. arXiv:1602.03842

Abbott et. al. (2016). *Tests of general relativity with GW150914*. arXiv:1602.03841

Abbott et. al. (2016). *Properties of the binary black hole merger GW150914*. arXiv:1602.03840

Abbott et. al. (2016). *GW150914: First results from the search for binary black hole coalescence with Advanced LIGO.* arXiv:1602.03839 [gr-qc]

Aasi et. al. (2015). *Searches for continuous gravitational waves from nine young supernova remnants.* ApJ, **813** 1 39

Aasi et. al. (2015). *Advanced LIGO.* Class. Quantum Grav., **32**, 074001

Aasi et. al. (2015). *Directed search for gravitational waves from Scorpius X-1 with initial LIGO data.* Phys. Rev. D. **91**, 062008

Aasi et. al. (2015). *Narrow-band search of continuous gravitational-wave signals from Crab and Vela pulsars in Virgo VSR4 data.* Phys. Rev. D. **91**, 022004

Aasi et. al. (2015). *Characterization of the LIGO detectors during their sixth science run.* Class. Quantum Grav., **32**, 11

Aasi et. al. (2015). *Searching for stochastic gravitational waves using data from the two colocated LIGO Hanford detectors.* Phys. Rev. D **91**, 022003

Aasi et. al. (2014). *Improved Upper Limits on the Stochastic Gravitational-Wave Background from 2009-2010 LIGO and Virgo Data*. Phys. Rev. Lett. **113**, 231101

Aartsen et. al. (2014). *Multimessenger search for sources of gravitational waves and high-energy neutrinos: Initial results for LIGO-Virgo and IceCube.* Phys. Rev. D **90**, 102002

Aasi et. al. (2014). *First all-sky search for continuous gravitational waves from unknown sources in binary systems.* Phys. Rev. D **90**, 062010

Aasi et. al. (2014). *Methods and results of a search for gravitational waves associated with gamma-ray bursts using the GEO 600, LIGO, and Virgo detectors*. Phys. Rev. D **89** 122004

Aasi et. al. (2014). *Search for gravitational radiation from intermediate mass black hole binaries in data from the second LIGO-Virgo joint science run.* Phys. Rev. D **89**, 122003

Aasi et. al. (2014). *Search for gravitational waves associated with gamma-ray bursts detected by the interplanetary network.* Phys. Rev. Lett. **113**, 011102

Aasi et. al. (2014). *Search for gravitational wave ringdowns from perturbed intermediate mass black holes in LIGO-Virgo data from 2005-2010.* Phys. Rev. D. **89**, 102006

Aasi et. al. (2014). *Implementation of an F-statistic all-sky search for continuous gravitational waves in Virgo VSR1 data.* Class. Quantum Grav. **31** 165014

Aasi et. al. (2014). *The NINJA-2 project: detecting and characterizing gravitational waveforms modelled using numerical binary black hole simulations.* Class. Quantum Grav. **31** 115004

Aasi et. al. (2014). *Application of a Hough search for continuous gravitational waves on data from the fifth LIGO science run.* Class. Quantum Grav. **31** 085014

Aasi et. al. (2014). *Constraints on cosmic strings from the LIGO-Virgo gravitational-wave detectors.* Phys. Rev. Lett. **112**, 131101

Aasi et. al. (2014). *First searches for optical counterparts to gravitational-wave candidate events.* ApJS **211** 7

Aasi et. al. (2014). *Gravitational waves from known pulsars: results from the initial detector era.* ApJ **785** 119

Aasi et. al. (2013). *Search for long-lived gravitational-wave transients coincident with long gamma-ray bursts.* Phys. Rev. D **88**, 122004

Aasi et. al. (2013). *Directed search for continuous gravitational waves from the Galactic center.* Phys. Rev. D **88**, 102002

Aasi et. al. (2013). *Parameter estimation for compact binary coalescence signals with the first generation gravitational-wave detector network.* Phys. Rev. D. **88**, 062001

Aasi et. al. (2013). *Enhanced sensitivity of the LIGO gravitational wave detector by using squeezed states of light.* Nature Photonics, **7**, 613-619.