Beth Willman

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Positions

Chair, Departments of Physics and Astronomy, Haverford College
July 2014 – present
Associate Professor of Astronomy, Haverford College
May 2014 – present
Assistant Professor of Astronomy, Haverford College
September 2008 – May 2014
Clay Fellow, Smithsonian Astrophysical Observatory
September 2006 – August 2008
James Arthur Fellow, New York University Center for Cosmology and Particle Physics
November 2003 – August 2006

Education

Ph.D., Astronomy, University of Washington, 2003
Advisor: Professor Julianne Dalcanton
Title: *A Survey For Resolved Milky Way Dwarf Satellites*
B.A., Astrophysics, Columbia University, 1998

Honors and Awards

Lindback Distinguished Teaching award, Haverford College, 2014
Kavli Frontiers of Science Fellow, 2013
Innovation in Teaching award, Haverford College, 2013
Life Cycle of the Student Scholar award, Haverford College, 2010

Research Interests

Near-field cosmology, dark matter, and galaxy formation
Planning for large sky surveys, big data, machine learning
Optical/IR/radio searches for and studies of the least luminous galaxies
Optical/IR/radio mapping of the Milky Way to its outermost reaches
N-body and N-body+SPH simulations of galaxy formation and evolution

Recent Grants

PI, NSF Faculty Early Career Development (AST-1151462) *CAREER: Exploring the Invisible Universe With Milky Way Dwarfs and Streams*, $759,519, Sept 2012 - Aug 2017
PI, NSF Astronomy and Astrophysics Research Grants (AST-0908193) *Collaborative Research: Searching for Ultra-Faint Galaxies Around the Milky Way*, $346,364, Sept 2009 - Aug 2013
PI, NSF Astronomy and Astrophysics Research Grants (AST-0908446) *Simulating the Milky Way's Halo*, $75,621, Sept 2009 - Aug 2011

Recent Invited Talks

2015: University of Chicago astronomy colloquium; NYU CCPP seminar; McGill astrophysics seminar; UMass Amherst and Five Colleges astronomy colloquium; University of Maryland Astronomy Colloquium

2014: Michigan State University astronomy seminar; MIT astrophysics colloquium; Observatorio Nacional in Rio de Janeiro Astronomy webinar; University of Toledo physics colloquium; Satellite Galaxies and Dwarfs in the Local Group conference, Potsdam, Germany; TMT in the Astronomical Landscape of the 2020s conference, Tucson, AZ

2013: Canadian Institute for Theoretical Astrophysics (CITA) seminar; Keynote speaker and breakout session leader at the Nebraska American Association of Physics Teachers workshop; Probes of Dark Matter on Galaxy Scales, AAS Topical Conference Series, Monterey, CA; Indiana University Astronomy colloquium; Lehigh University Physics colloquium

2012: Rochester Institute of Technology Physics colloquium; American Association of Physics Teachers *Frontiers in Astronomy* session; UC Davis Astronomy Seminar; Caltech Astronomy Colloquium; UCLA Physics and Astronomy Colloquium; Las Cumbres Observatory Astronomy Seminar; UC Santa Barbara Kavli Institute for Theoretical Physics *First Light and the Faintest Dwarfs* conference review of ultra-faint dwarfs; Columbia University Astronomy Colloquium

2011: Herzberg Institute for Astronomy Seminar; Tufts Astronomy Colloquium; Harvard-Smithsonian CfA Institute for Theory and Computation Colloquium; NOAO Steward Joint Astronomy Colloquium; UT Austin Astronomy Colloquium; Very Wide-Field Surveys in Light of Astro2010, StScI; 218th meeting of the American Astronomical Society in Boston, MA Plenary speaker; Harvard-Smithsonian Center for Astrophysics Clay Fellowship symposium talk; Widener University science seminar; Princeton Astronomy colloquium; 2011 LSST special session at 217th meeting of the AAS

Selected Press Since 2012

Press release about the discovery of the most distant stars in the Milky Way (Bochanski et al. 2014, e.g. bit.ly/1rHrw4W)

Beth Willman Really Does Have a Galaxy, http://www.theawl.com/2012/08/beth-willman-galaxy

Galaxies to get the Pluto treatment? The Register online (Willman & Strader 2012) (http://tinyurl.com/3c5jpfk)

Quoted in articles, including Scientific American articles about fossil galaxies (2014, http://www.scientificamerican.com/article/fossil-galaxy-segue1/) and Milky Way satellites (2013; http://tinyurl.com/klvvudz)

Professional Service

Chair/co-chair of the Stars, Milky Way and Local Volume Structure science collaboration of the Large Synoptic Survey Telescope (LSST), 2008 - present

Science Advisory Committee for LSST 2014 - present

Member of the AURA (Association of Universities for Research in Astronomy) Observatory Council 2013 - present (vice-chair 2014 - present)

WIYN 0.9m Executive Committee 2014

Member of the NOAO Telescope Allocation Committee 2012 - 2014

Member of the LSST Publication Board Jan 2012 - 2015

Scientific Organizing Committees, including the Aspen Summer 2014 workshop *Dwarf Galaxies as Cosmological Probes*, Potsdam Leibniz Institute for Astrophysics 2014 ThinkShop *Satellite Galaxies and Dwarfs in the Local Group*, University of Michigan 2015 *Local Group Astrostatistics* conference, GMT 2015 Community Science Workshop

Domestic and international grant review, including NSF review panels
Referee for MNRAS, Science, AJ, ApJ, ApJL, New Astronomy, Advances in Astronomy

Haverford Service

Chair of Physics and Astronomy department 2014 - 2015
Extensive curricular development, including Haverford's membership in the 0.9m KPNO telescope consortium and in the ARC 3.5m telescope on KPNO
Helped implement a new major (astrophysics) 2009
Faculty search committees for Bryn Mawr Physics 2010/2011 and for Haverford Astronomy 2012/2013
Steering committees for the Koshland Integrated Natural Science Center 2010/2011, 2013/2014 and for the Center for Peace and Global Citizenship 2012/2013
Instructional and Informational Technology working group 2013/2014
Admissions activities and student recruitment, 2008 - present

Selected Outreach

Public talks at the Quadrangle retirement village, Franklin Institute, Delaware Valley Astronomers Association, Chesmont Astronomy Association, Chester County Astronomical Society, Ruckman Lecture at the University of Nebraska, Delaware Astronomical Society, 2010 - 2014
Faculty advisor for Haverford's Strawbridge Observatory outreach program, now serving hundreds of visitors per year, 2009 - present

Postdocs Advised

Jonathan Hargis, *Studying the Milky Way's ultra-faint dwarfs and stellar streams*, Sept 2013 - present
John Bochanski, *Mapping the outer Milky Way with M giants*, Sept 2012 - Aug 2014, now faculty at Rider University
Ross Fadely, *Properties of the least luminous Milky Way satellites, star-galaxy separation algorithm development*, Sept 2010 - Aug 2012, now a postdoc at NYU

Graduate Students Advised

Adi Zolotov (NYU, along with D. W. Hogg), *The Dual Origin of Stellar Halos*, PhD 2011
Shane Walsh (ANU, along with H. Jerjen), *Tracing the Faintest Milky Way Satellites*, PhD 2009

Other Research Assistants

Brian Kimmig, September 2014 - present, *Spectroscopic Observations of the Eastern Banded Stream*
Shane Walsh, 2014, *Wide-field observations of the Crater Milky Way satellite*
Annie Preston (Haverford '12) October 2012 - July 2013, *Star-galaxy separation in SDSS Stripe 82*

Undergrad Research Students Advised

(* indicates thesis student)

*1. Gail Gutowski ('10, Geoscience PhD program UT Austin): Willman 1 spatial structure 2008 - 2010

*2. Dylan Hatt ('10, 2010 Fulbright fellow, Astronomy PhD program at University of Chicago): Searching for dwarfs in RCS2 2009 - 2010

*3. Alex Warres ('10, Masters program in CS at JHU): Kinematics of ultra-faint dwarfs 2009 - 2010

*4. Jennifer Campbell ('11, working in law office): Unresolved stars and galaxies, searching for stealth galaxies 2009 - 2011

*5. Oliver Elbert ('11, Physics PhD program UC Irvine): An LSST-like view of the Milky Way 2010 - 2011

*6. Maya Barlev ('12, 2012 Watson Fellow): Searching for stealth galaxies 2010 - 2012

*7. Erin Boettcher ('12, Astronomy PhD program at Wisconsin, 2014 NSF graduate fellow): KPNO 0.9m search for RR Lyrae in Milky Way companions 2011 - 2013

8. Emily Cunningham ('12, 2012 Fulbright fellow, 2013 NSF graduate fellow, Astronomy PhD program at UC Santa Cruz): KPNO 0.9m search for variable stars in Milky Way companions Spring 2011

9. Ivan Meehan ('12, Physics PhD program at UC Davis): Visualizing Simulated Stellar Halos 2009 - 2010

10. Andrew Sturner ('12, Physics PhD program at U Colorado, Boulder): www.thelocalgroup.info wiki setup 2009 - 2010

11. Samuel Storck-Post (Beloit '12, programmer at Epic in Madison, WI): Surface gravity separation of stars Summer 2011

12. Rebecca Nakaba (Bennington '13, Astronomy Masters program at Wesleyan): Surface gravity separation of stars Summer 2011

*13. Miriam Fuchs ('13, Science museum education): Searching for stealth galaxies, an empirical photometric metallicity relation for low-mass stars Summer 2010, 2012-2013

14. Alyssa Mayo ('13): Searching for ultra-faint dwarfs Summer 2011

*15. Mariah Baker ('14): Simulating the detectability of RR Lyrae stars in time-series KPNO 0.9m imaging, Summer 2012, 2013 - 2014

*16. Alex Dillaire ('14): KPNO 0.9m search for RR Lyrae in Milky Way companions, 2013 - 2014

*17. Erica Hopkins ('14, Data analyst): Simulating the detectability of RR Lyrae stars in time-series KPNO 0.9m imaging, Summer 2012, 2013 - 2014

18. Aspen deVries ('14): MOND, globular clusters, and dwarf galaxies Summer 2011

19. Ana Nourmahnad ('14): Searching for ultra-faint dwarfs Summer 2011

20. Eric Smith ('15): KPNO 0.9m search for RR Lyrae in Milky Way companions, Summer 2013 - Spring 2015

21. Tianyi Yang ('15): Studying satellite galaxy populations with ELVIS, 2014-2015

22. Marian Bechtel (Bryn Mawr '16): KPNO 0.9m search for RR Lyrae in Milky Way companions, Summer 2013

23. Andrea Gaughan ('16): KPNO 0.9m search for RR Lyrae in Milky Way companions, 2013 - 2014

24. Conor Hunt ('16, Wesleyan): Search for RR Lyrae in Bootes II, Summer 2014

25. Chris Garling ('17): A wide-field study of the Hercules dwarf, 2014 - 2015

Courses Taught

2008-2009 Academic Year
Modern Galactic Astronomy (11 students, upper-level, majors) - new class
2009-2010 Academic Year
Astronomical Ideas (63 students between two sections, non-majors)
Freshman seminar in a, strophysics (9 students, majors)
Observational Astronomy (6 students, upper-level, majors)
Introduction to Astrophysics II (9 students, intermediate-level, majors)
2010-2011 Academic Year
Astronomical Ideas (37 students)
Observational Astronomy (7 students)
Freshman Seminar in Astrophysics (17 students)
Modern Galactic Astronomy (11 students)
Introduction to Astrophysics II (3 students)
2011-2012 Academic Year
On junior leave
2012-2013 Academic Year
Astronomical Ideas (73 students between two sections)
Observational Astronomy (7 students)
Introduction to Astrophysics II (7 students)
2013-2014 Academic Year
Introduction to Astrophysics I (11 students)
Modern Galactic Astronomy (10 students)
The Persistent Lack of Diversity in the Sciences (15 students) – new class
2014-2015 Academic Year
Astronomical Ideas (50 students)
Observational Astronomy (9 students)
Introduction to Astrophysics II (11 students)
The Persistent Lack of Diversity in the Sciences (15 students)

Refereed Publications (* indicates papers where I was the first author or a student or Haverford postdoc under my primary supervision and support was the first author.)

*1. Hargis, J. R., **Willman, B.**, & Peter, A. H. G., 2014, *Too Many, Too Few, or Just Right? The Predicted Number and Distribution of Milky Way Dwarf Galaxies*, ApJL, 795, 13

2. Spekkens, K.. Urbancic, N., Mason, B. S., **Willman, B.;**, Aguirre, J. E., 2014, *The Dearth of Neutral Hydrogen in Galactic Dwarf Spheroidal Galaxies*, ApJL, 795, 5

*3. Bochanski, J., J., **Willman, B.**, Caldwell, N., Sanderson, R., West, A. A., Strader, J. & Brown, W., 2014, *The Most Distant Stars in the Milky Way*, ApJL, 790L, 5

*4. Bochanski, J., J., **Willman, B.**, West, A. A., Strader, J., & Chomiuk, L., 2014, *Hunting the Most Distant Stars in the Milky Way: Methods and Initial Results*, AJ, 147, 76

5. Natarajan, A., Peterson, J., Voytek, T., Spekkens, K., Mason, B., Aguirre, J., **Willman, B.**, 2013, *Bounds on Dark Matter Properties from Radio Observations of Ursa Major II using the Green Bank Telescope*, Phys Rev D, 88, 083535

*6. Boettcher, E., **Willman, B.**, Fadely, R., Strader, J. and eight additional Haverford student co-authors, 2013, *A Search for RR Lyrae Stars in Segue 2 and Segue 3*, AJ, 146, 94

7. Jerjen, H., Da Costa, G. S., **Willman, B.**, Tisserand, P., Arimoto, N., Okamoto, S., Mateo, M., Saviane, I., Walsh, S., Geha, M., Jordan, A., Olszewski, E., Walker, M., Zoccali, M. Kroupa, P., 2013, *Main Sequence Star Populations in the Virgo Overdensity Region*, ApJ, 769, 14

8. Zolotov, A. Brooks, A. M., **Willman, B.**, Governato, F., Pontzen, A., Christensen, C., Dekel, A., Quinn, T., Shen, S., Wadsley, J., 2012, *Baryons Matter: Why Luminous Satellite Galaxies Have Reduced Central Masses*, ApJ, 761, 71

*9. Fadely, R., Hogg, D. W., **Willman, B.**, 2012, *Star-Galaxy Classification in Multi-Band Optical Imaging*, ApJ, 760, 15

10. Sand, D. J., Strader, J., **Willman, B.**, Zaritsky, D., McLeod, B., Caldwell, N., Seth, A., Olszewski, E., 2012, *Tidal Signatures in the Faintest Milky Way Satellites: The Detailed Properties of Leo V, Pisces II and Canes Venatici II*, ApJ, 756, 79

*11. **Willman, B.** & Strader, J., 2012, *"Galaxy", Defined'*, AJ, 144, 76

*12. **Willman, B.**, Geha, M., Strader, J., Strigari, L. E., Simon, J. D., Kirby, E., Warres, A., 2011, *Willman 1 - a probable dwarf galaxy with an irregular kinematic distribution*, AJ, 142, 128

*13. Fadely, R., **Willman, B.**, Geha, M., Walsh, S., Munoz, R., Jerjen, H., Vargas, L., & DaCosta, G., 2011, *Segue 3: An Old, Extremely Low Luminosity Star Cluster in the Milky Way's Halo*, AJ, 142, 88

14. Simon, J. D., et al. – **Willman, B.** 9th of 12 authors, 2011, *A Complete Spectroscopic Survey of the Milky Way Satellite Segue 1: The Darkest Galaxy*, ApJ, 733, 46

15. Zolotov, A., Hogg, D. W., & **Willman, B**, 2011, *Are the Ultra-Faint Dwarf Galaxies Just Cusps?*, ApJL, 727, L14

*16. Zolotov, A., **Willman, B.** Brooks, A., Governato, F., Hogg, D. W., Shen, S., Wadsley, J. 2010, *The Dual Origin of Stellar Halos II: Chemical Abundances as Tracers of Formation History*, ApJ, 721, 738

17. Sand, D. J., Seth, A., Olszewski, E. W., **Willman, B.**, Zaritsky, D., & Kallivayalil, N. 2010, *A Deeper Look at Leo IV: Star Formation History and Extended Structure*, ApJ, 718, 530

18. Munoz, R. R., Geha, M., & **Willman B.** 2010, *Turning the Tides on the Ultra-Faint Dwarf Spheroidal Galaxies: Coma Berenices and Ursa Major II*, AJ, 140, 138

19. Governato, F. et al – **Willman** 8th of 11 authors, 2010, *Bulgeless dwarf galaxies and dark matter cores from supernova-driven outflows*, Nature, 463, 7278, 203

*20. **Willman, B.**, 2010, *In Pursuit of the Least Luminous Galaxies*, Advances in Astronomy, vol. 2010, Article ID 285454, 11 pages, 2010. doi:10.1155/2010/285454.

21. Frebel, A., Simon, J. D., Geha, M., & **Willman, B.** 2010, *High-Resolution Spectroscopy of Extremely Metal-Poor Stars in the Least Evolved Galaxies: Ursa Major II and Coma Berenices*, ApJ, 708, 560

22. Sand, D. J. Olszewski, E. W., **Willman, B.**, Zaritsky, D., Seth, A., Harris, J., Piatek, S., &, Saha, A. 2009 *The Star Formation History and Extended Structure of the Hercules Milky Way Satellite*, ApJ, 704, 898

23. Governato, F., et al. – **Willman, B.** 5th of 11 authors 2009, *Forming a Large Disk Galaxy from a z<1 Major Merger*, MNRAS, 398, 312

*24. Zolotov, A., **Willman, B.**, Brooks, A. M., Governato, F., Brook, C. B., Hogg, D. W., Quinn, T., & Stinson, G. 2009, *The Dual Origin of Stellar Halos*, ApJ, 702, 1058

25. Geha, M., **Willman, B.**, Simon, J. D., Strigari, L. E., Kirby, E. N., Law, D. R., & Strader, J. 2009, *The Least-Luminous Galaxy: Spectroscopy of the Milky Way Satellite Segue 1*, ApJ, 692, 1464

*26. Walsh, S. M., **Willman, B.**, & Jerjen, H. 2009, *The Invisibles: A Detection Algorithm to Trace the Faintest Milky Way Satellites*, AJ, 137, 450

27. Brook, C. B., Governato, F., Quinn, T., Wadsley, J., Brooks, A. M., **Willman, B.**, Stilp, A., & Jonsson, P. 2008, *The Formation of Polar Disk Galaxies*, ApJ, 689, 678

28. Tollerud, E. J., Bullock, J. S., Strigari, L. E., & **Willman, B.** 2008, *Hundreds of Milky Way Satellites? Luminosity Bias in the Satellite Luminosity Function*, ApJ, 688, 277

*29. Walsh, S., **Willman, B.**, Sand, D., Harris, J., Seth, A., Zaritsky, D., & Jerjen, H., 2008, *Bootes II ReBooted: An MMT/MegaCam Study of An Ultra-Faint Milky Way Satellite*, ApJ, 688, 245

30. Strigari, L., Bullock, J., Kaplinghat, M., Simon, J., Geha, M., **Willman, B.**, & Walker, M., 2008, *A common mass scale for satellite galaxies of the Milky Way*, Nature 454:1096-1097, 2008

31. Strigari, L. E., Koushiappas, S. M., Bullock, J. S., Kaplinghat, M., Simon, J. D., Geha, M., & **Willman, B.** 2008, *The Most Dark Matter Dominated Galaxies: Predicted Gamma-ray Signals from the Faintest Milky Way Dwarfs*, ApJ, 678, 641

32. Younger, J., Besla, G., Cox T. J., Hernquist, L, Robertson B., & **Willman, B.**, 2008, *On the Origin of Dynamically Cold Rings Around the Milky Way*, ApJL, 676, 21

33. Walsh, S., Jerjen, H. & **Willman B.**, 2007, *A Pair of Bootes: A New Milky Way Satellite*, ApJL, 662, 883

34. Brooks, A., Governato, F., Booth, C., **Willman B.**, Gardner, J.P., Wadsley, J., Stinson, G., & Quinn, T., 2007, *The Origin and Evolution of the Mass-Metallicity Relationship for Galaxies: Results from Cosmological N-Body Simulations*, ApJL, 655, 17

35. Governato, F., **Willman, B.**, Mayer, L. Brooks, A., Stinson, G., Valenzuela, O. Wadsley, J., & Quinn, T., 2007, *Forming Disk Galaxies in Lambda CDM Simulations*, MNRAS, 374, 1479

36. Zucker, D et al. – (**Willman, B.** 19th of 32 authors), 2006, *A New Milky Way Dwarf Satellite in Canes Venatici*, ApJL, 643, 103

37. Belokurov, V et al. – (**Willman, B.** 10th of 33 authors), 2006, *A Faint New Milky Way Satellite in Bootes*, ApJL, 647, 111

38. Zucker, D et al. – (**Willman, B.** 11th of 33 authors), 2006, *A Curious Milky Way Satellite in Ursa Major*, ApJL, 650, 41

*39. **Willman, B.**, Dalcanton, J. J., Martinez-Delgado, D., West, A., Blanton, M., Hogg, D.W., 2005, *A New Milky Way Dwarf Galaxy in Ursa Major*, ApJL, 626, 85

*40. **Willman, B.**, Blanton, M., West, A., Dalcanton, J.J., Hogg, D.W., Schneider, D., Wherry, N., Yanny, B., Brinkmann, J., 2005, *A New Milky Way Companion: Unusual Globular Cluster or Extreme Dwarf Satellite?*, AJ, 129, 2692

*41. **Willman, B.**, Governato, F., Dalcanton, J.J., Reed, D., Quinn, T., 2004, *The Observed and Predicted Spatial Distribution of Milky Way Satellites*, MNRAS, 353, 639

*42. **Willman, B.**, Governato, F., Mayer, L., Quinn, T., 2004, *The Origin and Evolution of Intracluster Stars*, MNRAS, 355, 159

43. Governato, F., Mayer, L., Wadsley, J., Gardner, J. P., **Willman, B.**, Hayashi, E., Quinn, T., Stadel, J., & Lake, G. 2004, *The Formation of a Realistic Disk Galaxy in Lambda Dominated Cosmologies*, ApJ, 607, 688

*44. **Willman, B.**, Dalcanton, J., Ivezić, Ž., Schneider, D. P., & York, D. G., 2002, *An SDSS Survey for Dwarf Galaxy Companions to the Milky Way II: High-Velocity Clouds in the EDR*, AJ, 124, 2600

*45. **Willman, B.**, Dalcanton, J., Ivezić, Ž, Jackson, T., Lupton, R., Brinkmann, J., Hennessy, G., & Hindsley, R., 2002, *An SDSS Survey for Dwarf Galaxy Companions to the Milky Way I: Detection Limits*, AJ, 123, 848

46. Helfand, D. J., Stone, R. P. S., **Willman, B.,** White, R. L., Becker, R. H., Price, T., Gregg, M. D., & McMahon, R. G. 2001, *Long-Term Optical Variability of Radio-selected Quasars from the FIRST Survey*, AJ, 121, 1872

47. Ivezić, Ž., et al. 2000, *Candidate RR Lyrae Stars Found in Sloan Digital Sky Survey Commissioning Data*, AJ, 120, 963

Selected Unrefereed Publications

*48. LSST Science Collaborations (237 co-authors), 2009, *LSST Science Book, Version 2.0*, arXiv:0212.0201 (**Willman, B.**, lead of 17 co-authors on the Milky Way and Local Volume Structure chapter of this 596 page manuscript).

*49. **Willman, B.**, Masjedi, M., Hogg, D.W., Dalcanton, J. J., Martinez-Delgado, D., Blanton, M., West, A., Dotter, A. & Chaboyer, B., 2006, *Willman 1 - A Galactic Satellite At 40 kpc With Multiple Stellar Tails*, arXiv:astro-ph/0603486

50. Governato, F., **Willman, B.**, & Mayer L., 2005, *Cosmological Simulations of Galaxy Formation II: Matching the Observational Properties of Disk Galaxies*, Procs. of the "Island Universes: Structure and Evolution of Disk Galaxies" Terschelling, Netherlands