

# Steven R. Furlanetto

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## Biographical Information

Date of Birth: September 23, 1976

Citizenship: USA

## Current Employment

2009– Associate Professor of Physics and Astronomy, University of California - Los Angeles

## Past Employment

2008–9 Assistant Professor of Physics and Astronomy, University of California - Los Angeles

2006–7 Assistant Professor of Physics, Yale University

2003–5 Lee A. DuBridge Prize Fellow in Theoretical Physics and Astrophysics, California Institute of Technology

## Education

Harvard University, Cambridge, MA

Ph. D., Astronomy, 2003 (Advisor: Abraham Loeb)

A. M., Astronomy, 2001

University of Cambridge, UK

Certificate of Advanced Study in Mathematics, 1999

Passed with Distinction

Carleton College, Northfield, MN

B. A., Physics, 1998

Summa Cum Laude with Distinction in Physics

### Honors and Awards

- 2010 Alfred P. Sloan Fellowship
- 2008 David & Lucile Packard Fellowship in Science and Engineering
- 2008 Bok Prize, Harvard University Department of Astronomy
- 2006 Robert J. Trumpler Award, Astronomical Society of the Pacific
- 2003 Edward Fireman Award, Harvard University
- 2002–2003 John Parker Scholarship (Harvard University Merit Fellowship)  
Astronomy 1)  
Science A-35)
- 1999–2002 NSF Graduate Research Fellowship
- 1999 Loomis Award, Harvard University Department of Astronomy
- 1999 Tyson Medal, University of Cambridge
- 1998–1999 Winston S. Churchill Fellowship

### Professional Activities

- Collaborator, Mileura Widefield Array (Low-Frequency Radio Observatory)
- Referee for *The Astrophysical Journal*, *The Astrophysical Journal Letters*, *Monthly Notices of the Royal Astronomical Society*, *Astronomy & Astrophysics*, *Nature*, *Physical Review D*, and *Physical Review Letters*
- Member of Scientific Organizing Committees for “Astrophysics and Cosmology from the 21-cm Background,” (Aspen, CO, June-July 2010); “Cosmological Reionization,” (Allahabad, India; February 2010); “Cross-correlations for Reionization” (Stockholm, Sweden; August 2009); “Reionization@Ringberg” (Ringberg, Germany; March 2009); “Far Away: Light in the young universe at redshifts beyond three” (XXIVe IAP Colloquium; Paris, July 2008); “From Planets to Dark Energy: The Modern Radio Universe” (Manchester, UK, Oct. 2007); “First Light and Reionization: Theoretical Study and Experimental Detection of the First Luminous Sources in the Universe” (Irvine, CA, May 2005)
- Member, American Astronomical Society
- Member, Phi Beta Kappa
- Member, Sigma Xi

### Public Outreach

- Astronomy Moderator, MadSci Network (<http://www.madsci.org>), 2000–5

**Invited Conference Presentations**

- Harvesting the Desert: The Universe Between Redshift 1 and 3 (Seventh International Marseille Cosmology Conference), “The Epoch of Helium Reionization,” Marseille, France (June 2009)
- MIT Theory Retreat, Three lecture series on “High-Redshift Structure Formation and the 21 cm Line,” New Hampshire (January 2009)
- Great Surveys Workshop, “Theoretical Perspectives on the Epoch of Reionization,” Santa Fe, NM (November 2008)
- Santa Fe Cosmology Workshop 2008, “21 cm Cosmology,” Santa Fe, NM (July 2008)
- The Fifth Harvard-Smithsonian Conference on Theoretical Astrophysics: 21 cm Cosmology, “21 cm Cosmology: An Overview,” Cambridge, MA (May 2008)
- Astrophysics in the Next Decade: JWST and Concurrent Facilities, “The Intergalactic Medium at High Redshifts,” Tucson, AZ (September 2007)
- Chicago-3 Community Workshop: Implementation of the SKA Program for the U.S. Community, “The 21 cm Frontier,” Washington, DC (September 2007)
- Science in the Era of TMT, “Reionization from High-Redshift Galaxy Searches,” Irvine, CA (July 2007)
- American Physical Society Meeting, “Theoretical Models of Reionization,” Jacksonville, FL (April 2007)
- Building the Foundation for U.S. Astronomy at m/cm Wavelengths in 2010 and Beyond, “Cosmology and Future Radio Telescopes,” Tucson, AZ (August 2006)
- The End of the Dark Ages, “The Twilight Zone of Reionization,” Space Telescope Science Institute, Baltimore, MD (March 2006)
- Reionizing the Universe, “Analytic Models of Inhomogeneous Reionization,” Groningen, The Netherlands (June 2005)
- First Light and Reionization: Theoretical Study and Experimental Detection of the First Luminous Sources in the Universe, “Bubble, Bubble, Toil, and Trouble: 21 cm Measurements of the High-Redshift Universe,” Irvine, CA (May 2005)
- Probing Galaxies Through Quasar Absorption Lines (IAU Symposium 199), “Quasar Absorption Lines at High Redshifts: Through a Glass Darkly,” Shanghai, China (March 2005)
- 1st Arizona/Heidelberg Symposium: The High Redshift Frontier, “21cm Observations of the Reionization Epoch,” Tucson, AZ (December 2004)
- SKA 2004, “Observing Neutral Hydrogen in the Epoch of Reionization,” Penticton, Canada (July 2004)
- URSI National Radio Science Meeting, “The 21 cm Forest,” Boulder, CO (January 2004)

**Other Invited Talks (from January 2007)**

University of California, Los Angeles “Professor in the Union;” November 18, 2008

University of California, Irvine Astrophysics Seminar; November 4, 2008

University of California, San Diego Astrophysics Seminar; October 21, 2008

University of California, Los Angeles Physics Colloquium; October 16, 2008

Harvard-Smithsonian CfA Colloquium (Bok Prize Lecture); March 20, 2008

California Institute of Technology Theoretical Astrophysics and Relativity Seminar; March 14, 2008

Kavli Institute for Cosmological Physics Seminar, University of Chicago; February 29, 2008

Center for Cosmology and Astro-Particle Physics Seminar; The Ohio State University; February 5, 2008

Rutgers University Physics & Astronomy Colloquium; December 5, 2007

Columbia University Astrophysics Colloquium; October 17, 2007

Massachusetts Institute of Technology Astronomy Colloquium; May 1, 2007

Renaissance Technologies Science Colloquium; March 6, 2007

Dartmouth University Physics & Astronomy Colloquium; March 2, 2007

NOVA speaker, Leiden Observatory Colloquium; February 1, 2007

NOVA speaker, Kapteyn Astronomical Institute Colloquium (Groningen, the Netherlands); January 29, 2007

### Refereed Publications

- Furlanetto, S. R.** & Dixon, K. L. “Large-Scale Fluctuations in the HeII Lyman- $\alpha$  Forest and HeII Reionization,” 2010, submitted to *The Astrophysical Journal* (arXiv.org/0910.5246 [astro-ph])
- Furlanetto, S. R.** & Johnson Stoever, S. “Secondary ionization and heating by fast electrons,” 2010, in press at *Monthly Notices of the Royal Astronomical Society* (arXiv.org/0910.4410 [astro-ph])
- Mesinger, A. & **Furlanetto, S. R.** “The inhomogeneous ionizing background following reionization,” 2009, *Monthly Notices of the Royal Astronomical Society*, 400, 1461
- Dixon, K. L. & **Furlanetto, S. R.** “The evolution of the helium-ionizing background at  $z \sim 2-3$ ,” 2009, submitted to *The Astrophysical Journal*, 706, 970
- Furlanetto, S. R.** “Fluctuations in the Ionizing Background During and After Helium Reionization,” 2009, *The Astrophysical Journal*, 703, 702
- Furlanetto, S. R.** & Oh, S. P. “The Temperature-Density Relation of the Intergalactic Medium After Hydrogen Reionization,” 2009, *The Astrophysical Journal*, 701, 94
- Furlanetto, S. R.** “Spatial Correlations in the Helium-ionizing Background,” 2009, *The Astrophysical Journal*, 700, 1666
- Bolton, J. S., Oh, S. P., & **Furlanetto, S. R.** “The evolution of the Lyman- $\alpha$  forest effective optical depth following HeII reionization,” 2009, *Monthly Notices of the Royal Astronomical Society*, 396, 2405
- Bolton, J. S., Oh, S. P., & **Furlanetto, S. R.** “Photo-heating and the fate of hard photons during the reionization of HeII by quasars,” 2009, *Monthly Notices of the Royal Astronomical Society*, 395, 736
- Furlanetto, S. R.** & Mesinger, A. “The ionizing background at the end of reionization,” 2009, *Monthly Notices of the Royal Astronomical Society*, 394, 1667
- D’Aloiso, A., **Furlanetto, S. R.**, & Natarajan, P. “The abundance of lensing protoclusters,” 2009, *Monthly Notices of the Royal Astronomical Society*, 394, 1469
- Lidz, A., Zahn, O., **Furlanetto, S. R.**, McQuinn, M., Hernquist, L., & Zaldarriaga, M. “Probing Reionization with the 21 cm-Galaxy Cross Power Spectrum,” 2009, *The Astrophysical Journal*, 690, 252
- Furlanetto, S. R.**, Haiman, Z., & Oh, S. P. “Fossil Ionized Bubbles Around Dead Quasars During Reionization,” 2008, *The Astrophysical Journal*, 686, 25
- Furlanetto, S. R.** & Oh, S. P. “Inhomogeneous Helium Reionization and the Equation of State of the Intergalactic Medium,” 2008, *The Astrophysical Journal*, 682, 14
- Furlanetto, S. R.** & Oh, S. P. “The History and Morphology of Helium Reionization,” 2008, *The Astrophysical Journal*, 681, 1
- Mesinger, A. & **Furlanetto, S. R.** “Ly $\alpha$  emitters during the early stages of reionization,” 2008, *Monthly Notices of the Royal Astronomical Society*, 386, 1990

- Mesinger, A. & **Furlanetto, S. R.** “Ly $\alpha$  damping wing constraints on inhomogeneous reionization,” 2008, *Monthly Notices of the Royal Astronomical Society*, 385, 1348
- Adshead, P. & **Furlanetto, S. R.** “Reionization and the large-scale 21 cm-cosmic microwave background cross correlation,” 2008, *Monthly Notices of the Royal Astronomical Society*, 384, 291
- D’Aloiso, A. & **Furlanetto, S. R.** “High-redshift voids in the excursion set formalism,” 2007, *Monthly Notices of the Royal Astronomical Society*, 382, 860
- Mesinger, A. & **Furlanetto, S. R.** “Efficient Simulations of Early Structure Formation and Reionization,” 2007, *The Astrophysical Journal*, 669, 663
- Furlanetto, S. R.** & Furlanetto, M. R. “Spin exchange rates in proton-hydrogen collisions,” 2007, *Monthly Notices of the Royal Astronomical Society*, 379, 130
- Furlanetto, S. R.** & Lidz, A. “The Cross-Correlation of High-Redshift 21 cm and Galaxy Surveys,” 2006, *The Astrophysical Journal*, 660, 1030
- Pritchard, J. R. & **Furlanetto, S. R.** “21 cm fluctuations from inhomogeneous X-ray heating before reionization,” 2007, *Monthly Notices of the Royal Astronomical Society*, 376, 1680
- Furlanetto, S. R.** & Furlanetto, M. R. “Spin exchange rates in electron-hydrogen collisions,” 2007, *Monthly Notices of the Royal Astronomical Society*, 374, 547
- Pritchard, J. R., **Furlanetto, S. R.**, & Kamionkowski, M. “Galaxy surveys, inhomogeneous reionization, and dark energy,” 2007, *Monthly Notices of the Royal Astronomical Society*, 374, 159
- Zahn, O., Lidz, A., McQuinn, M., Dutta, S., Hernquist, L., Zaldarriaga, M., & **Furlanetto, S. R.** “Simulations and Analytic Calculations of Bubble Growth During Hydrogen Reionization,” 2007, *The Astrophysical Journal*, 654, 12
- McQuinn, M., Zahn, O., Zaldarriaga, M., Hernquist, L., & **Furlanetto, S. R.** “Cosmological Parameter Estimation Using 21 cm Radiation from the Epoch of Reionization,” 2007, *The Astrophysical Journal*, 653, 815
- Furlanetto, S. R.** & Oh, S. P. “Redshifted 21 Centimeter Emission from Minihalos Before Reionization,” 2006, *The Astrophysical Journal*, 652, 849
- Furlanetto, S. R.**, Oh, S. P., & Pierpaoli, E. “The Effects of Dark Matter Decay and Annihilation on the High-Redshift 21 cm Background,” 2006, *Physical Review D*, 74, 103502
- Furlanetto, S. R.** & Pritchard, J. R. “The Scattering of Lyman-series Photons in the Intergalactic Medium,” 2006, *Monthly Notices of the Royal Astronomical Society*, 372, 1093
- Furlanetto, S. R.**, Oh, S. P., & Briggs, F. H. “Cosmology at Low Frequencies: The 21 cm Transition and the High-Redshift Universe,” 2006, *Physics Reports*, 433, 181

- Sigurdson, K. & **Furlanetto, S. R.** “Measuring the Primordial Deuterium Abundance During the Cosmic Dark Ages,” 2006, *Physical Review Letters*, 97, 091301
- Furlanetto, S. R.** “The Global 21 Centimeter Background from High Redshifts,” 2006, *Monthly Notices of the Royal Astronomical Society*, 371, 867
- Furlanetto, S. R.** “The 21-cm Forest,” 2006, *Monthly Notices of the Royal Astronomical Society*, 370, 1867
- Pritchard, J. R. & **Furlanetto, S. R.** “Descending From On High: Lyman Series Cascades and Spin-Kinetic Temperature Coupling in the 21 cm Line,” 2006, *Monthly Notices of the Royal Astronomical Society*, 367, 1057
- Lidz, A., Oh, S. P., & **Furlanetto, S. R.** “Have We Detected Patchy Reionization in Quasar Spectra?,” 2006, *The Astrophysical Journal Letters*, 639, L47
- Furlanetto, S. R.** & Kamionkowski, M. “Pair Correlations and Merger Bias,” 2006, *Monthly Notices of the Royal Astronomical Society*, 366, 529
- Furlanetto, S. R.** & Piran, T. “The Evidence of Absence: Galaxy Voids in the Excursion Set Formalism,” 2006, *Monthly Notices of the Royal Astronomical Society*, 366, 467
- Furlanetto, S. R.**, Zaldarriaga, M., & Hernquist, L. “The Effects of Reionization on Ly $\alpha$  Galaxy Surveys,” 2006, *Monthly Notices of the Royal Astronomical Society*, 365, 1012
- Furlanetto, S. R.**, McQuinn, M., & Hernquist, L. “Characteristic Scales During Reionization,” 2006, *Monthly Notices of the Royal Astronomical Society*, 365, 115
- Milosavljević, M., Miller, C. J., **Furlanetto, S. R.**, & Cooray, A. “Cluster Merger Variance and the Luminosity Gap Statistic,” 2006, *The Astrophysical Journal Letters*, 637, L9
- Furlanetto, S. R.** & Oh, S. P. “Taxing the Rich: Recombinations and Bubble Growth During Reionization,” 2005, *Monthly Notices of the Royal Astronomical Society*, 363, 1031
- Furlanetto, S. R.** & Loeb, A. “Is Double Reionization Physically Plausible?” 2005, *The Astrophysical Journal*, 634, 1
- McQuinn, M., **Furlanetto, S. R.**, Hernquist, L., Zahn, O., & Zaldarriaga, M. “The Kinetic Sunyaev-Zel’dovich Effect from Reionization,” 2005, *The Astrophysical Journal*, 630, 643
- Cooray, A. & **Furlanetto, S. R.** “Polarization Signals of the 21 cm Background from the Era of Reionization,” 2005, *Monthly Notices of the Royal Astronomical Society*, 359, L47
- Furlanetto, S. R.**, Phillips, L. A., & Kamionkowski, M. “Highly-Ionized Oxygen Absorbers in the Intergalactic Medium,” 2005, *Monthly Notices of the Royal Astronomical Society*, 359, 295
- Furlanetto, S. R.**, Schaye, J., Springel, V., & Hernquist, L. “Ly $\alpha$  Emission from Structure Formation,” 2005, *The Astrophysical Journal*, 622, 7

- Oh, S. P. & **Furlanetto, S. R.** “How Universal is the Gunn-Peterson Trough at  $z \sim 6$ ? A Closer Look at the Quasar SDSS J1148+5251,” 2005, *The Astrophysical Journal Letters*, 620, L9
- Yoshida, N., **Furlanetto, S. R.**, & Hernquist, L. “The Temperature Structure of the Warm-Hot Intergalactic Medium,” 2005, *The Astrophysical Journal Letters*, 618, L91
- Furlanetto, S. R.**, Hernquist, L., & Zaldarriaga, M., “Constraining the Topology of Reionization Through Ly $\alpha$  Absorption,” 2004, *Monthly Notices of the Royal Astronomical Society*, 354, 695
- Furlanetto, S. R.**, Zaldarriaga, M., & Hernquist, L. “Statistical Probes of Reionization With 21 cm Tomography,” 2004, *The Astrophysical Journal*, 613, 16
- Furlanetto, S. R.**, Zaldarriaga, M., & Hernquist, L. “The Growth of HII Regions During Reionization,” 2004, *The Astrophysical Journal*, 613, 1
- Furlanetto, S. R.** & Loeb, A. “Large-scale Structure Shocks at Low and High Redshifts,” 2004, *The Astrophysical Journal*, 611, 642
- Zaldarriaga, M., **Furlanetto, S. R.**, & Hernquist, L. “21 Centimeter Fluctuations from Cosmic Gas at High Redshifts,” 2004, *The Astrophysical Journal*, 608, 622
- Cooray, A. & **Furlanetto, S. R.**, “Free-Free Emission at Low Radio Frequencies,” 2004, *The Astrophysical Journal Letters*, 606, L5
- Furlanetto, S. R.**, Schaye, J., Springel, V., & Hernquist, L. “Ultraviolet Line Emission from Metals in the Low-Redshift Intergalactic Medium,” 2004, *The Astrophysical Journal*, 606, 221
- Furlanetto, S. R.**, Sokasian, A., & Hernquist, L. “Observing the Reionization Epoch Through 21-cm Radiation,” 2004, *Monthly Notices of the Royal Astronomical Society*, 347, 187
- Furlanetto, S. R.**, Schaye, J., Springel, V., & Hernquist, L. “Mapping the Cosmic Web with Ly $\alpha$  Emission,” 2003, *The Astrophysical Journal Letters*, 599, L1
- Furlanetto, S. R.** & Loeb, A. “Metal Absorption Lines as Probes of the Intergalactic Medium Prior to the Reionization Epoch,” 2003, *The Astrophysical Journal*, 588, 18
- Furlanetto, S. R.** & Loeb, A. “The 21 cm Forest: Radio Absorption Spectra as Probes of Minihalos Before Reionization,” 2002, *The Astrophysical Journal*, 579, 1
- Furlanetto, S. R.** & Loeb, A. “Emission of Positron Annihilation Line Radiation by Clusters of Galaxies,” 2002, *The Astrophysical Journal*, 572, 796
- Furlanetto, S. R.** & Loeb, A. “Identifying Gamma-Ray Burst Remnants Through Positron Annihilation Radiation,” 2002, *The Astrophysical Journal Letters*, 569, 91
- Furlanetto, S. R.** & Loeb, A. “Constraining the Collisional Nature of Dark Matter Through Observations of Gravitational Wakes,” 2002, *The Astrophysical Journal*, 565, 854

**Furlanetto, S. R.** & Loeb, A. “Intergalactic Magnetic Fields from Quasar Outflows,” 2001, *The Astrophysical Journal*, 556, 619

### Other Publications

**Furlanetto, S. R.** et al. “Astrophysics from the Highly-Redshifted 21 cm Line,” 2009, *Astro2010: The Astronomy and Astrophysics Decadal Survey*, Science White Papers, no. 83

**Furlanetto, S. R.** et al. “Cosmology from the Highly-Redshifted 21 cm Line,” 2009, *Astro2010: The Astronomy and Astrophysics Decadal Survey*, Science White Papers, no. 82

**Furlanetto, S. R.** “The High-Redshift Intergalactic Medium,” 2008, *Science in the Era of JWST*, eds. M. Stiavelli & H. Thronson, Springer

**Furlanetto, S. R.** “Bubble, bubble, toil, and trouble: 21 cm measurements of the high-redshift universe,” 2006, *New Astronomy Reviews*, 50, 157

McQuinn, M., **Furlanetto, S. R.**, Hernquist, L., Zahn, O., & Zaldarriaga, M. “The kinetic Sunyaev Zel’dovich effect from reionization,” 2006, *New Astronomy Reviews*, 50, 84

Nagamine, K., Cen, R., **Furlanetto, S. R.**, Hernquist, L., Night, C., Ostriker, J. P., & Ouchi, M. “Tracing early structure formation with massive starburst galaxies and their implications for reionization,” 2006, *New Astronomy Reviews*, 50, 29

**Furlanetto, S. R.** “Quasar Absorption Lines At High Redshift: Through a Glass Darkly,” 2005, Proceedings of the International Astronomical Union Colloquium 199: *Probing Galaxies through Quasar Absorption Lines*, eds. P. R. Williams, C.-G. Shu and B. Menard (Cambridge: Cambridge University Press), p. 349

Carilli, C. L., Gnedin, N., **Furlanetto, S. R.**, & Owen, F. “Observations of HI 21-cm absorption by the neutral IGM during the epoch of reionization with the Square Kilometer Array,” 2004, in “Science with the Square Kilometer Array,” eds. C. Carilli and S. Rawlings, *New Astronomy Reviews*, 48, 1053

**Furlanetto, S. R.**, & Briggs, F. H. “21 cm tomography of the high-redshift universe with the Square Kilometer Array,” 2004, in “Science with the Square Kilometer Array,” eds. C. Carilli and S. Rawlings, *New Astronomy Reviews*, 48, 1039

Carilli, C. L., **Furlanetto, S. R.**, Briggs, F., Jarvis, M., Rawlings, S., & Falcke, H. “Probing the dark ages with the Square Kilometer Array,” 2004, in “Science with the Square Kilometer Array,” eds. C. Carilli and S. Rawlings, *New Astronomy Reviews*, 48, 1029

**Furlanetto, S. R.** & Loeb, A. “Intergalactic Magnetic Fields from Quasar Outflows,” Proceedings of the MPA/ESO/MPE/USM Joint Astronomy Conference *Lighthouses of the Universe: The Most Luminous Celestial Objects and Their Use for Cosmology*, eds. M. Gilfanov, R. Sunyaev, & E. Churazov (New York: Springer, 2002), 450