

# Stefan W. Ballmer

## Curriculum Vitae

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Citizenship: Switzerland	Web: tinyurl.com/s-w-ballmer

### RECENT AND CURRENT POSITIONS

Aug 2010 - **Assistant Professor of Physics**  
present Syracuse University, Syracuse, NY

Jun 2013 - **Research leave at the LIGO Hanford Observatory**  
Jul 2014 Commissioning the Advanced LIGO interferometer

Dec 2009 - **NAOJ Visiting Researcher**  
Aug 2010 at the National Astronomical Observatory of Japan.

Sep 2009 - **JSPS Postdoctoral Fellow** (Gaikokujin Tokubetsu Kenkyuin)  
Nov 2009 at the National Astronomical Observatory of Japan.

Jul 2006 - **Robert A. Millikan Postdoctoral Fellow**  
Aug 2009 California Institute of Technology, Pasadena, CA

### EDUCATION

Jun 2006 **Ph.D. Physics, Massachusetts Institute of Technology (MIT), Cambridge, MA**  
Experimental Astrophysics, Laser Interferometer Gravitational Wave Observatory (LIGO).

Apr 2000 **Diploma** (equivalent to Master of Science), **Physics, Swiss Federal Institute of Technology (ETH) Zurich, Switzerland**  
With honor, in Theoretical Physics (Cosmology).

### RESEARCH INTERESTS

Gravitational Wave Physics, Observational Cosmology,  
Quantum Mechanics of Macroscopic Objects

### SELECTED PUBLICATIONS

Only papers with significant personal contribution listed

- Stefan W. Ballmer, David J. Ottaway. "New class of optical beams for large baseline interferometric gravitational wave detectors", *Phys. Rev. D* 88, 062004 (2013).
- J. Abadie, ...S. Ballmer, ... and J. Zweizig. (The LIGO Scientific Collaboration), "Upper limits on a stochastic gravitational-wave background using LIGO and Virgo interferometers at 600-1000 Hz", *Phys. Rev. D* 85, 122001 (2012).
- N. Smith-Lefebvre, S. Ballmer, M. Evans, S. Waldman, K. Kawabe, V. Frolov, N. Mavalvala "Optimal alignment sensing of a readout mode cleaner cavity", *Opt. Lett.* 2011 Vol. 36, Issue 22, pp. 4365-4367. (2011)

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- J. Abadie, ...S. Ballmer, ... and J. Zweizig. (The LIGO Scientific Collaboration), "Directional Limits on Persistent Gravitational Waves Using LIGO S5 Science Data", *Phys. Rev. Lett.* **107**, 271102 (2011).
- S. Ballmer, S. Marka, P. Shawhan, "Feasibility of measuring the Shapiro time delay over meter-scale distances", *Class. Quantum Grav.* **27** 185018 (2010)
- E. Thrane, S. Ballmer, J. D. Romano, S. Mitra, D. Talukder, S. Bose, V. Mandic, "Probing the anisotropies of a stochastic gravitational-wave background using a network of ground-based laser interferometers" *Phys. Rev. D* **80**, 122002 (2009).
- M. Anholm, S. Ballmer, J. D. E. Creighton, L. R. Price, X. Siemens, "Optimal strategies for gravitational wave stochastic background searches in pulsar timing data", *Phys. Rev. D* **79**, 084030 (2009).
- M. Evans, S. Ballmer, M. Fejer, P. Fritschel, G. Harry, G. Ogin "Thermo-optic noise in coated mirrors for high-precision optical measurements" *Phys. Rev. D* **78**, 102003 (2008).
- S. Mitra, S. Dhurandhar, T. Souradeep, A. Lazzarini, V. Mandic, S. Bose, S. Ballmer, "Gravitational wave radiometry: Mapping a stochastic gravitational wave background" *Phys. Rev. D* **77**, 042002 (2008).
- Stefan W. Ballmer. "A Radiometer for Stochastic Gravitational Waves", *Class. Quantum Grav.* **23** S179-S185, 2006.
- E. Katsavounidis, S. Ballmer. "For how long will gravitational waves remain hidden?" *Phys. Lett. A, Vol 347, Issues 1-3, 14 Nov 2005, Pages 33-37.*
- D. Ottaway, J. Betzwieser, S. Ballmer. "In-situ measurement of absorption in high power interferometers using beam diameter measurements" *Opt. Lett.* **2006 Vol. 31, Issue 4, pp. 450-452.**
- B. Abbott, ...S. Ballmer, ... and J. Zweizig. (The LIGO Scientific Collaboration), "An upper limit on the stochastic gravitational-wave background of cosmological origin" *Nature* **460** (2009) 990.
- B. Abbott, ...S. Ballmer, ... and J. Zweizig. (The LIGO Scientific Collaboration), "Observation of a kilogram-scale oscillator near its quantum ground state" *New J. Phys.* **11** (2009) 073032.
- B. Abbott, ...S. Ballmer, ... and J. Zweizig. (The LIGO Scientific Collaboration), "LIGO: The Laser Interferometer Gravitational-Wave Observatory" *Rep. Prog. Phys.* **72** (2009) 076901.
- B. Abbott, ...S. Ballmer, ... and J. Zweizig. (The LIGO Scientific Collaboration), "Upper limit map of a background of gravitational waves" *Phys. Rev. D* **76**, 082003 (2007).
- B. Abbott, ...S. Ballmer, ... and J. Zweizig. (The LIGO Scientific Collaboration), "Searching for a Stochastic Background of Gravitational Waves with the Laser Interferometer Gravitational-Wave Observatory" *Astrophys. J.* **659** (2007) 918.
- B. Abbott, ...S. Ballmer, ... and J. Zweizig. (The LIGO Scientific Collaboration, ALLEGRO) "First cross-correlation analysis of interferometric and resonant-bar gravitational-wave data for stochastic backgrounds" *Phys. Rev. D* **76**, 022001 (2007).
- B. Abbott, ...S. Ballmer, ... and J. Zweizig. (The LIGO Scientific Collaboration), "Upper Limits on a Stochastic Background of Gravitational Waves" *Phys. Rev. Lett* **95**, 221101 (2005).
- B. Abbott, ...S. Ballmer, ... and J. Zweizig. (The LIGO Scientific Collaboration) "Detector description and performance for the first coincidence observations between LIGO and GEO" *Nucl. Instrum. Meth., A* **517** pp 154-179, 2004.

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- B. Abbott, ...S. Ballmer, ... and J. Zweizig. (The LIGO Scientific Collaboration), "Analysis of first LIGO science data for stochastic gravitational wave", *Physical Review D Vol 69*, p 122004, 2004.

## Book Chapter Publication:

- S. Ballmer, K. Somiya, "Methods of Improving Thermal Noise", Chapter 6 of "Optical Coatings and Thermal Noise in Precision Measurement", Edited by Harry, Bodiya, DeSalvo, ISBN:9781107003385 (2012) (LIGO DCC P1000175)

## PAPERS IN PROGRESS

- A. Perreca, J. Lough, D. Kelley, S. W. Ballmer, "Multi-dimensional optical trapping of a mirror ", P1300224, currently in LSC collaboration review.
- S. Ballmer et. al. "Increasing the Advanced LIGO sensitivity, a conceptual design"
- J. Lough, R. Fisher, S. Ballmer, "Real-time characterization of Advanced LIGO data"

## GRANTS

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|------|--|
| 2014 | <b>NSF CAREER: Detector Technology and Science Education in the Era of Gravitational Wave Astrophysics</b> , Development of adaptive mode-matching for Advanced LIGO's output mode cleaner, 5 years, PHY-1352511, PI: Stefan Ballmer |
| 2011 | <b>NSF: Searching for a Stochastic Background, aLIGO Rare Transient Monitoring and Optical Mirror Trapping</b> , 3 years, PHY-1068809, PI: Stefan Ballmer  |

## COLLABORATION POSITIONS AND SERVICE

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|----------------|--|
| 2011 - present | Chair of LIGO Advanced Interferometer Configurations "green" team  |
| 2011 - present | Chair of the LIGO detector characterization "glitch" group   |
| 2012           | Member of KAGRA (Large Cryogenic Gravitational-Wave Telescope, Japan) External Review Committee (2nd review) |
| 2007 - 2012    | Co-chair of the LIGO stochastic gravitational wave background search group                                   |
| 2011           | Member of LIGO-India evaluation team   |
| 2011           | Member of KAGRA (Large Cryogenic Gravitational-Wave Telescope, Japan) External Review Committee (1st review) |

## AWARDS

- |      |  |
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| 2012 | <b>Teaching award</b> , Physics Department, Syracuse University  |
| 2009 | <b>JSPS Postdoctoral Fellowship for Foreign Researcher</b> (Gaikokujin Tokubetsu Kenkyuin), Japan Society for the Promotion of Science |

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- 2006      **Robert A. Millikan Postdoctoral Prize Fellowship** for Experimental Astrophysics, California Institute of Technology
- 2006      **Honorable Mention, GWIC** (Gravitational Wave International Committee) **Thesis Prize**
- 2003      **Alan H. Barrett Prize** for Excellence in Astrophysics (awarded to the best student in Astrophysics), Massachusetts Institute of Technology
- 2001      **Bruno Rossi Graduate Fellowship**,  
Massachusetts Institute of Technology
- 2000      **Polya-Fonds Award** for outstanding graduates,  
Swiss Federal Institute of Technology, Switzerland

## PRESENTATIONS

### Invited Talks

- Stefan Ballmer, "Experimental Challenges in Gravitational-Wave Astronomy", Colloquium, Fermilab, May 2013
- Stefan Ballmer, "Advanced LIGO, Advanced VIRGO and KAGRA: Precision Measurement for Astronomy", Miami 2012 conference, Fort Lauderdale, December 2012
- Stefan Ballmer, "Progress in Gravitational Wave Detection at LIGO", Frontiers in Optics / Laser Science XXVIII, Rochester NY, Oct 2012
- Stefan Ballmer, "Beyond Advanced LIGO: Astronomy and Astrophysics with Third-generation Gravitational-wave Detectors", Rattle and Shine, July 2012, KITP Santa Barbara
- Stefan Ballmer, "Prospects and challenges for Gravitational-wave astronomy", APS April meeting, March 2012 (Abstract ID: BAPS.2012.APR.B8.1)
- Stefan Ballmer, "2nd and 3rd generation gravitational-wave detectors", Physics Colloquium, University of Massachusetts Amherst, November 2011
- Stefan Ballmer, "2nd and 3rd generation gravitational-wave detectors", Physics Colloquium, Rochester Institute of Technology, November 2011
- Stefan Ballmer, "Advanced LIGO", Rencontres de Moriond, March 2011, *Cancelled due to natural disaster in Japan*
- Stefan Ballmer, "Searching for Big Bang relicts with LIGO"; Gravitational Waves 2010 workshop at University of Minnesota, Oct 14-16 2010
- Stefan Ballmer, "An upper limit on the stochastic gravitational-wave background of cosmological origin", HEAP 2009 Workshop, KEK, Tsukuba Japan, November 2009
- Stefan Ballmer, "Precision length measurements in LIGO: Finding gravitational waves and more", Physics Colloquium, University of Washington, Seattle, April 2008
- Stefan Ballmer (for the LIGO Scientific Collaboration). "The LIGO Gravitational Wave Antennae, Nuts and Bolts and Current Sensitivity", Frontiers in Contemporary Physics III, Vanderbilt University, Nashville, TN, May 2005.

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## Conference Presentations

- Stefan Ballmer, "Lavender design ideas", Advantages of longer arm length gravitational-wave detectors, May 2013, GWADW La Biodola, Isola d'Elba, Italy
- Stefan Ballmer, "Optical Techniques for Reducing Thermal Noise", Gravitational Wave Advanced Detector Workshop, May 2013, GWADW La Biodola, Isola d'Elba, Italy
- Stefan Ballmer, "Green team design ideas" for upgrading Advanced LIGO, Gravitational Wave Advanced Detector Workshop, May 2012, Waikoloa, Hawaii
- Stefan Ballmer, "Stress-Optic noise?", Gravitational Wave Advanced Detector Workshop, May 2011, La Biodola, Isola d'Elba, Italy
- Stefan Ballmer "Thoughts on optimizing coating thermal noise", GWADW May 2010, Kyoto, Japan
- Stefan Ballmer. "Laser Interferometry and Pulsar Timing: Looking for a Stochastic Gravitational Wave Background", International Pulsar Timing Array Meeting, Aug. 2008 Arecibo, PR
- Stefan Ballmer (for the LIGO / VIRGO Scientific Collaboration). "Building an International Gravitational Wave Network", AAS 211th Meeting, Austin, TX Jan. 2008
- Stefan Ballmer (for the LIGO Scientific Collaboration). "Estimating the Spatial Structure of a Stochastic Gravitational Wave Background", GWDAW 12, Cambridge, MA, Dec. 2007
- Stefan Ballmer. "Noise Couplings in the Laser Interferometer Gravitational Wave Observatory (LIGO)", Laser Science XIII, San Jose, CA, Sep. 2007
- Stefan Ballmer. "Upper Limit Map of a Stochastic Background of Gravitational Waves", AAS 209th Meeting, Thesis presentation, Seattle, WA, Jan. 2007
- Stefan Ballmer. "Upper Limit Map of a Stochastic Gravitational Wave Background", Poster presentation, 23rd Texas Symposium on Relativistic Astrophysics, Melbourne, Australia, Dec 2006
- Stefan Ballmer (for the LIGO Scientific Collaboration). "Status of LIGO and what the future holds, Toward joint EM/GW observations", Transient Universe 2006, Kavli Institute for Theoretical Physics, Santa Barbara, CA, Mar. 2006
- Stefan Ballmer (for the LIGO Scientific Collaboration). "Upper Limits on Stochastic Background of Gravitational Waves", 6th Edoardo Amaldi Conference on Gravitational Waves, Okinawa Japan, June 2005.
- Stefan Ballmer. "Pictures from LIGO – The Radiometer", LIGO Science Collaboration (LSC) meeting Cambridge, MA, Nov 2005.
- Stefan Ballmer. "Status of the Gravitational Wave Radiometer search", LIGO Science Collaboration (LSC) meeting Hanford, WA, Aug 2005.
- Stefan Ballmer. "Commissioning Progress and Plans, Hanford Observatory", LIGO Science Collaboration (LSC) meeting, Livingston, LA, March 2005.
- Stefan Ballmer. "Directional Stochastic Search: a Gravitational Wave Radiometer", LIGO Science Collaboration (LSC) meeting Hanford, WA, Aug 2004.

## LIGO TECHNICAL DOCUMENTS

- "Online State Vector System", S. Ballmer, D. Brown, R. Fisher (2013, T1300542)

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- "Online Detector Characterization System Overview", S. Ballmer, D. Brown, P. Couvares, R. Fisher, J. Lough, J. Smith (2012, T1200323)
- "Advanced LIGO Length Sensing and Control Final Design", R. Abbott, R. Adhikari, S. Ballmer, L. Barsotti, M. Evans, P. Fritschel, V. Frolov, G. Mueller, (2010, T1000298)
- "AdvLIGO Interferometer Sensing and Control Conceptual Design", R. Abbott, R. Adhikari, S. Ballmer, L. Barsotti, M. Evans, P. Fritschel, V. Frolov, G. Mueller, B. Slagmolen, S. Waldman (2007, T070247-01-I)
- "Interferometer Sensing and Control (ISC) Design Requirements", R. Adhikari; S. Ballmer; P. Fritschel (2007, T070236-00-D)
- "Arm Cavity Finesse for Advanced LIGO", P. Fritschel, R. Adhikari, S. Ballmer, M. Evans (2007, T070303-01-D)
- "Optical Absorption in Initial LIGO IFOs", David Ottaway, Stefan Ballmer, Joe Betzweiser, K. Kawabe, Bill Kells, Malik Rakhmanov, Rick Savage and Sam Waldman (2005, T050074-00-R)
- "Thermal Compensation System Description", Stefan Ballmer, Valera Frolov, Ryan Lawrence, Bill Kells, Gerardo Moreno, Ken Mason, David Ottaway, Michael Smith, Cheryl Vorvick, Phil Willems and Mike Zucker (2005, T050064-00-R)
- "Description of the Angular Sensing and Control (ASC) system in H1 during the third LIGO Science run (S3)", Luca Matone, Stefan Ballmer, Matt Evans, Peter Fritschel Nergis Mavalvala, Virginio Sannibale, Rick Savage, Paul Schwinberg, Daniel Sigg (2003, T030290-00-D)

## COURSES TAUGHT

Since 2010	<b>Theory of Relativity I (PHY785) (Spring 2013)</b> <b>Syracuse University</b> Graduate level.
	<b>Electromagnetism II (PHY425) (Spring 2011 &amp; Spring 2012)</b> <b>Syracuse University</b> Undergraduate level.
	<b>Major Concepts in Physics I (PHY101) (Fall 2011 &amp; Fall 2012)</b> <b>Syracuse University</b> Undergraduate level for non-physicists.
Sep 2009 - Dec 2009	<b>Course on Stochastic Gravitational Wave Background</b> <b>National Astronomical Observatory of Japan</b> Graduate level.

## DEPARTMENT SERVICE

2012	Member of the Graduate Admissions Committee, Physics Department, Syracuse University
2012	Presenter, SUPA (Syracuse University Project Advance) day in New York City
2011	Member of the Physics Department Graduate Curriculum Committee, Syracuse University
2011	Syracuse University Graduate Opening Day

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2010 Syracuse University Undergraduate Research Day

## RESEARCH STUDENTS SUPERVISED

Antonio Perreca (post-doc), James Lough (graduate), David Kelley (graduate), Fabian Magaña-Sandoval's (graduate), Almir Alemeic (undergraduate), Philippe Lewalle (undergraduate)

## REFEREE SERVICE

Physical Review Letters, Physical Review D, Classical and Quantum Gravity

## ADDITIONAL SKILLS AND ACTIVITIES

Flight Instructor Airplane Single Engine, Instrument Airplane (CFII); Commercial Pilot Airplane Single Engine Land, Instrument Airplane; Private Pilot Privileges: Single Engine Sea; Swiss and Japanese Private Pilot license; Member of Syracuse Flying Club and Caltech / JPL Flying Club (AACIT).

Languages English and French (fluent); German (native); Japanese (basic)

## REFERENCES

available upon request

Stefan W. Ballmer