



Robert L. Byer

The William R. Kenan, Jr. Professor and Professor of Photon Science
Applied Physics

 Curriculum Vitae available Online

CONTACT INFORMATION

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Bio

BIO

Robert L. Byer has served as President of The American Physical Society, of the Optical Society of America and of the IEEE LEOS. He has served as Vice Provost and Dean of Research at Stanford. He has been Chair of the Department of Applied Physics, Director of the Edward L. Ginzton Laboratory and Director of the Hansen Experimental Physics Laboratory. He is a founding member of the California Council on Science and Technology and served as Chair from 1995-1999. He was a member of the Air Force Scientific Advisory Board from 2002-2006 and has been a member of the National Ignition Facility since 2000.

Robert L. Byer has conducted research and taught classes in lasers and nonlinear optics at Stanford University since 1969. He has made extraordinary contributions to laser science and technology including the demonstration of the first tunable visible parametric oscillator, the development of the Q-switched unstable resonator Nd:YAG laser, remote sensing using tunable infrared sources and precision spectroscopy using Coherent Anti Stokes Raman Scattering (CARS). Current research includes precision laser measurements in support of the detection of gravitational waves and laser "Accelerator on a chip".

ACADEMIC APPOINTMENTS

- Professor, Applied Physics
- Professor, Photon Science Directorate
- Member, Bio-X

ADMINISTRATIVE APPOINTMENTS

- Director, Edward L. Ginzton Laboratory, (2006-2009)
- Co-Director, Stanford Photonics Research Center, (2000- present)
- Chair, Department of Applied Physics, (2000-2002)
- Director, Hansen Experimental Physics Laboratory, (1997-2006)
- Director, Center for Nonlinear Optical Materials, (1992-2000)
- Dean of Research / Vice Provost, Stanford University, (1987-1992)
- Associate Dean of Humanities and Sciences, Stanford University, (1984-1986)

- Chair, Department of Applied Physics, (1981-1984)
- Professor, Department of Applied Physics, (1979- present)
- Associate Professor, Department of Applied Physics, (1974-1979)
- Assistant Professor, Department of Applied Physics, (1969-1974)

HONORS AND AWARDS

- Charter Fellow, National Academy of Inventors (2012)
- Frederic Ives Medal/Jarvis W. Quinn Prize, Optical Society of America (2009)
- Photonics Award, Institute of Electrical and Electronics Engineers (2009)
- Willis E. Lamb Award for Laser Science and Quantum Optics, Physics of Quantum Electronics (2009)
- Distinction in Photonics Award, Spectra Photonics (2004)
- 3rd Millennium Medal, Institute of Electrical and Electronics Engineers (2000)
- Fellow, California Council on Science and Technology (1999)
- A.L. Schawlow Award, Laser Institute of America (1998)
- Fellow, Laser Institute of America (1998)
- R.W. Wood Prize, Optical Society of America (1998)
- Quantum Electronics Award, Lasers and Electro-Optics Society (1996)
- Fellow, American Physical Society (1992)
- Fellow, American Association for the Advancement of Science (1992)
- Fellow, Lasers and Electro-optics Society of the IEEE (1987)
- R.V. Pole Memorial Lecture, Conference on Lasers and Electro-Optics (1987)
- Fellow, Optical Society of America (1976)
- Adolph Lomb Medal, Optical Society of America (1972)
- Fellow, I.B.M. (1969)

BOARDS, ADVISORY COMMITTEES, PROFESSIONAL ORGANIZATIONS

- President, American Physical Society (2012 - 2013)
- Vice President, American Physical Society (2011 - 2012)
- Chair, California Council on Science and Technology (1995 - 1998)
- President, Optical Society of America (1994 - 1995)
- President, Lasers and Electro-Optics Society of the IEEE (1984 - 1985)

PATENTS

- Konstantin L. Vodopyanov, Samuel T. Wong, Robert L. Byer. "United States Patent 8,384,990 Infrared frequency comb methods, arrangements and applications", Feb 26, 2013
- Robert L. Byer, Tomas Plettner. "United States Patent 7,994,472 Laser-driven deflection arrangements and methods involving charged particle beams", Aug 9, 2011
- Brett A. Allard, Saps Buchman, Robert L. Byer, Ke-Xun Sun. "United States Patent 7,751,170 Charge management of electrically isolated objects via modulated photoelectric charge transfer", Jul 6, 2010
- Robert L. Byer, Michel J.F. Digonnet, Jens Limpert, Supriyo Sinha. "United States Patent 7,477,672 Mitigation of photodarkening to achieve laser oscillation and amplification with highly doped fibers", Jan 13, 2009
- Graham S. Allen, Robert L. Byer, Ke-Xun Sun. "United States Patent 7,414,730 High precision interferometer apparatus employing a grating beamsplitter", Aug 19, 2008
- Robert L. Byer, Shailendhar Saraf, Arun Kumar Sridharan. "United States Patent 7,087,447 Method for fabricating zig-zag slabs for solid state lasers", Aug 8, 2006

- Martin M. Fejer, Gregory D. Miller, Robert G. Batchko, Robert L. Byer. "United States Patent 6,555,293 Method for fabricating efficient sources of electromagnetic radiation", Apr 29, 2003
- Robert L. Byer, Martin M. Fejer, Gregory D. Miller, Lawrence E. Myers. "United States Patent 6,156,255 Electric field domain patterning", Dec 5, 2000
- Robert L. Byer, Todd Rutherford, William Tulloch. "United States Patent 6,134,258 Transverse-pumped slab laser/amplifier", Oct 17, 2000
- Robert L. Byer, Justin D. Mansell. "United States Patent 6,108,121 Micromachined high reflectance deformable mirror", Aug 22, 2000
- Robert L. Byer, Robert C. Eckardt, Martin M. Fejer, Lawrence E. Myers. "United States Patent 6,064,512 Patterned poled structure devices having increased aperture size, increased power handling and three dimensional patterning capabilities", May 16, 2000
- Robert L. Byer, Martin M. Fejer, Eric J. Lim. "United States Patent 5,838,702 Method of electrically controlling regions of ferroelectric polarization domains in solid state bodies", Nov 17, 1998
- Robert L. Byer, Martin M. Fejer, Eric J. Lim. "United States Patent 5,714,198 Method of controlling regions of ferroelectric polarization domains in solid state bodies", Feb 3, 1998
- Robert L. Byer, Martin M. Fejer, Eric J. Lim. "United States Patent 5,714,198 Method of controlling regions of ferroelectric polarization domains in solid state bodies", Feb 3, 1998
- Robert L. Byer. "United States Patent 5,673,281 Solid state system for frequency conversion using raman-active media and non-linear media", Sep 30, 1997
- Anthony J. Alfrey, Robert L. Byer, Robert J. Shine Jr.. "United States Patent 5,479,430 Protective coating for solid state slab lasers", Dec 26, 1995
- Robert L. Byer, Martin M. Fejer, Leslie A. Gordon. "United States Patent 5,475,526 Method using a monolithic crystalline material for producing radiation by quasi-phase-matching, diffusion bonded monolithic crystalline material for quasi-phase-matching, and method for fabricating same", Dec 12, 1995
- Robert L. Byer, Martin M. Fejer, Leslie A. Gordon. "United States Patent 5,355,247 Method using a monolithic crystalline material for producing radiation by quasi-phase-matching, diffusion bonded monolithic crystalline material for quasi-phase-matching, and method for fabricating same", Oct 11, 1994
- Robert L. Byer, Martin M. Fejer, Stephan Schiller, Andreas Sizmann. "United States Patent 5,227,911 Monolithic total internal reflection optical resonator", Jul 13, 1993
- Robert L. Byer, Martin M. Fejer, Gregory A. Magel. "United States Patent 5,171,400 Method of producing crystalline rods having regions of reversed dominant ferroelectric polarity and method for clarifying such a rod", Dec 15, 1992
- Robert L. Byer, Amado Cordova, Michael Dignonnet, Martin Fejer, Celestino Gaeta, Herbert J. Shaw, Shoichi Sudo. "United States Patent 5,077,087 Method of cladding single crystal optical fiber", Dec 31, 1991
- Robert L. Byer, Alan C. Nilsson. "United States Patent 5,043,996 Monolithic nonplanar ring oscillator and method", Aug 27, 1991
- Amado Cordova, Robert L. Byer, Michael Dignonnet, Martin M. Fejer, Celestino Gaeta, Herbert J. Shaw, Shoichi Sudo. "United States Patent 5,037,181 Claddings for single crystal optical fibers and devices and methods and apparatus for making such claddings", Aug 6, 1991
- Robert L. Byer, Martin M. Fejer, Eric J. Lim. "United States Patent 5,036,220 Nonlinear optical radiation generator and method of controlling regions of ferroelectric polarization domains in solid state bodies", Jul 30, 1991
- Robert L. Byer, C. David Nabors. "United States Patent 5,027,360 High power continuous wave injection-locked solid state laser", Jun 25, 1991
- Robert L. Byer, William J. Kozlovsky, Charles D. Nabors. "United States Patent 5,027,361 Efficient laser harmonic generation employing a low-loss external optical resonator", Jun 25, 1991
- Santanu Basu, Robert L. Byer. "United States Patent 4,951,294 Diode pumped modelocked solid state laser", Aug 21, 1990
- Santanu Basu, Robert L. Byer. "United States Patent 4,914,663 Generation of short high peak power pulses from an injection mode-locked Q-switched laser oscillator", Apr 3, 1990
- Robert L. Byer, Thomas J. Kane. "United States Patent 4,902,127 Eye-safe coherent laser radar", Feb 20, 1990
- Santanu Basu, Robert L. Byer. "United States Patent 4,890,289 Fiber coupled diode pumped moving solid state laser", Dec 26, 1989
- Robert L. Byer, Martin M. Fejer. "United States Patent 4,880,297 Quantum well optical electric field biased nonlinear method and apparatus", Nov 14, 1989
- Robert L. Byer, Tso Y. Fan. "United States Patent 4,860,295 Cladding for transverse-pumped solid-state laser", Aug 22, 1989
- Santanu Basu, Robert L. Byer. "United States Patent 4,833,682 Moving slab laser", May 23, 1989
- Robert L. Byer, Tso Y. Fan. "United States Patent 4,809,291 Diode pumped laser and doubling to obtain blue light", Feb 28, 1989
- Robert L. Byer, Tso Y. Fan, William J. Kozlovsky. "United States Patent 4,764,933 Diode pumped low doped Nd³⁺ glass laser", Aug 16, 1988
- Robert L. Byer, George J. Dixon, Thomas J. Kane. "United States Patent 4,739,507 Diode end pumped laser and harmonic generator using same", Apr 19, 1988
- Robert L. Byer, Tso Y. Fan. "United States Patent 4,731,787 Monolithic phasematched laser harmonic generator", Mar 15, 1988
- Robert L. Byer, Tso Y. Fan. "United States Patent 4,701,928 Diode laser pumped co-doped laser", Oct 20, 1987

- Robert L. Byer, Martin M. Fejer, Gregory A. Magel. "United States Patent 4,650,322 Method and means for high resolution measurement of fiber diameter", Mar 17, 1987
- Robert L. Byer, Martin M. Fejer, John L. Nightingale. "United States Patent 4,607,776 Apparatus for translating crystal fibers", Aug 26, 1986
- Robert L. Byer, Thomas J. Kane. "United States Patent 4,578,793 Solid-state non-planar internally reflecting ring laser", Mar 25, 1986
- Robert L. Byer. "United States Patent 4,555,786 High power solid state laser", Nov 26, 1985
- Robert L. Byer. "United States Patent 4,455,657 Stable single axial mode Q switched laser oscillator with injection locking", Jun 19, 1984
- Robert L. Byer, Edward R. Murray, Arne Rosengreen, Jan E. van der Laan. "United States Patent 4,450,356 Frequency-mixed CO2 laser radar for remote detection of gases in the atmosphere", May 22, 1984
- Robert L. Byer, Martin M. Fejer. "United States Patent 4,421,721 Apparatus for growing crystal fibers", Dec 20, 1983
- Keith E. Bennett, Robert L. Byer. "United States Patent 4,398,806 Broadband variable optical attenuator", Aug 16, 1983
- Robert L. Byer. "United States Patent 4,386,854 Method and means for optically generating signals for use in monitoring an environment using tomographic techniques", Jun 7, 1983
- Robert L. Byer, John M. Eggleston III. "United States Patent 4,378,601 Slab and holder for face pumped slab laser", Mar 29, 1983
- Roger T. Boos, Robert L. Byer, Richard K. DeFreez, Walter D. Egan. "United States Patent 4,362,388 Remote measurement of concentration of a gas specie by resonance absorption", Dec 7, 1982
- Robert L. Byer, Richard L. Herbst. "United States Patent 4,310,808 High power laser employing an unstable resonator", Jan 12, 1982
- Robert L. Byer, Richard L. Herbst. "United States Patent 4,213,060 Tunable infrared source employing Raman mixing", Jul 15, 1980
- Robert L. Byer, Jeffrey A. Paul. "United States Patent 4,172,663 Optical wavelength meter", Oct 30, 1979
- Robert L. Byer, Richard L. Herbst. "United States Patent 3,922,561 Tunable electromagnetic oscillator using [01.4] grown LiNbO3 and method", Nov 25, 1975

LINKS

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Teaching

COURSES

2016-17

- MODERN OPTICS - LABORATORY: EE 236AL (Aut)
- Modern Optics: EE 236A (Aut)

2015-16

- Lasers Laboratory: APPPHYS 304 (Win)
- Modern Optics: EE 236A (Aut)

2014-15

- Lasers Laboratory: APPPHYS 304 (Win)
- Modern Optics: EE 236A (Aut)

STANFORD ADVISEES

Postdoctoral Faculty Sponsor

Si Tan

Doctoral (Program)

Alexander Ody

Publications

PUBLICATIONS

- **A fully programmable 100-spin coherent Ising machine with all-to-all connections.** *Science*
McMahon, P. L., Marandi, A., Haribara, Y., Hamerly, R., Langrock, C., Tamate, S., Inagaki, T., Takesue, H., Utsunomiya, S., Aihara, K., Byer, R. L., Fejer, M. M., Mabuchi, et al
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- **GW151226: Observation of Gravitational Waves from a 22-Solar-Mass Binary Black Hole Coalescence** *PHYSICAL REVIEW LETTERS*
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- **Demonstration of acceleration of relativistic electrons at a dielectric microstructure using femtosecond laser pulses.** *Optics letters*
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- **Properties of the Binary Black Hole Merger GW150914** *PHYSICAL REVIEW LETTERS*
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- **GW150914: First results from the search for binary black hole coalescence with Advanced LIGO** *PHYSICAL REVIEW D*
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2014; 86 (4): 1337-1389
- **Electron beam position monitor for a dielectric microaccelerator** *OPTICS LETTERS*
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- **Coherent Ising machine based on degenerate optical parametric oscillators** *PHYSICAL REVIEW A*
Wang, Z., Marandi, A., Wen, K., Byer, R. L., Yamamoto, Y.
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- **Demonstration of electron acceleration in a laser-driven dielectric microstructure** *NATURE*
Peralta, E. A., Soong, K., England, R. J., Colby, E. R., Wu, Z., Montazeri, B., MCGUINNESS, C., McNeur, J., Leedle, K. J., Walz, D., Sozer, E. B., Cowan, B., Schwartz, et al
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- **> 10 watt fiber laser structure with 0.5-5 MHz repetition rate and 0.5-1.5 pulse width** *FIFTH INTERNATIONAL SYMPOSIUM ON LASER PRECISION MICROFABRICATION*

- Kane, T. J., Smoliar, L. A., Adams, F., Arbore, M. A., BALSLEY, D. R., BYER, M., Conway, G., Grossman, W. M., KEATON, G., Kmetec, J. D., Leonardo, M., Morehead, J. J., Wiechmann, et al
2004; 5662: 496-500
- **QUASI-PHASE-MATCHED OPTICAL PARAMETRIC OSCILLATORS IN BULK PERIODICALLY POLED LINBO3** *JOURNAL OF THE OPTICAL SOCIETY OF AMERICA B-OPTICAL PHYSICS*
Myers, L. E., Eckardt, R. C., Fejer, M. M., Byer, R. L., Bosenberg, W. R., Pierce, J. W.
1995; 12 (11): 2102-2116
 - **QUASI-PHASE-MATCHED 2ND HARMONIC-GENERATION - TUNING AND TOLERANCES** *IEEE JOURNAL OF QUANTUM ELECTRONICS*
Fejer, M. M., Magel, G. A., Jundt, D. H., Byer, R. L.
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 - **HIGH-RESOLUTION SPECTROSCOPY OF WHISPERING GALLERY MODES IN LARGE DIELECTRIC SPHERES** *OPTICS LETTERS*
Schiller, S., Byer, R. L.
1991; 16 (15): 1138-1140
 - **COHERENCE PROPERTIES OF A DOUBLY RESONANT MONOLITHIC OPTICAL PARAMETRIC OSCILLATOR** *JOURNAL OF THE OPTICAL SOCIETY OF AMERICA B-OPTICAL PHYSICS*
NABORS, C. D., Yang, S. T., Day, T., Byer, R. L.
1990; 7 (5): 815-820
 - **CONTINUOUS-WAVE OPERATION AT 2.1-MU-M OF A DIODE-LASER-PUMPED, TM-SENSITIZED HO-Y3AL5O12 LASER AT 300-K** *OPTICS LETTERS*
Fan, T. Y., Huber, G., Byer, R. L., MITZSCHERLICH, P.
1987; 12 (9): 678-680
 - **DIODE-PUMPED CONTINUOUS-WAVE ND-GLASS LASER** *OPTICS LETTERS*
Kozlovsky, W. J., Fan, T. Y., Byer, R. L.
1986; 11 (12): 788-790
 - **EFFICIENT, FREQUENCY-STABLE LASER-DIODE-PUMPED ND-YAG LASER** *OPTICS LETTERS*
Zhou, B. K., Kane, T. J., Dixon, G. J., Byer, R. L.
1985; 10 (2): 62-64
 - **SINGLE AXIAL MODE-OPERATION OF A Q-SWITCHED ND-YAG OSCILLATOR BY INJECTION SEEDING** *IEEE JOURNAL OF QUANTUM ELECTRONICS*
Park, Y. K., Giuliani, G., Byer, R. L.
1984; 20 (2): 117-125
 - **COHERENT ANTI-STOKES RAMAN-SCATTERING FROM SMALL VOLUMES** *OPTICS LETTERS*
Gustafson, E. K., Byer, R. L.
1984; 9 (6): 220-222
 - **COHERENT ANTI-STOKES RAMAN-SPECTROSCOPY** *APPLIED PHYSICS LETTERS*
Begley, R. F., Harvey, A. B., Byer, R. L.
1974; 25 (7): 387-390
 - **Effects of waveform model systematics on the interpretation of GW150914** *CLASSICAL AND QUANTUM GRAVITY*
Abbott, B. P., Abbott, R., Abbott, T. D., ABERNATHY, M. R., Acernese, F., Ackley, K., Adams, C., Adams, T., Addesso, P., Adhikari, R. X., Adya, V. B., Affeldt, C., Agathos, et al
2017; 34 (10)
 - **Search for continuous gravitational waves from neutron stars in globular cluster NGC 6544** *PHYSICAL REVIEW D*
Abbott, B. P., Abbott, R., Abbott, T. D., ABERNATHY, M. R., Acernese, F., Ackley, K., Adams, C., Adams, T., Addesso, P., Adhikari, R. X., Adya, V. B., Affeldt, C., Agathos, et al
2017; 95 (8)
 - **First Search for Gravitational Waves from Known Pulsars with Advanced LIGO** *ASTROPHYSICAL JOURNAL*
Abbott, B. P., Abbott, R., Abbott, T. D., ABERNATHY, M. R., Acernese, F., Ackley, K., Adams, C., Adams, T., Addesso, P., Adhikari, R. X., Adya, V. B., Affeldt, C., Agathos, et al

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- **Calibration of the Advanced LIGO detectors for the discovery of the binary black-hole merger GW150914** *PHYSICAL REVIEW D*
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2017; 95 (6)
- **Upper Limits on the Stochastic Gravitational-Wave Background from Advanced LIGO's First Observing Run** *PHYSICAL REVIEW LETTERS*
Abbott, B. P., Abbott, R., Abbott, T. D., ABERNATHY, M. R., Acernese, F., Ackley, K., Adams, C., Adams, T., Addesso, P., Adhikari, R. X., Adya, V. B., Affeldt, C., Agathos, et al
2017; 118 (12)
- **Directional Limits on Persistent Gravitational Waves from Advanced LIGO's First Observing Run** *PHYSICAL REVIEW LETTERS*
Abbott, B. P., Abbott, R., Abbott, T. D., ABERNATHY, M. R., Acernese, F., Ackley, K., Adams, C., Adams, T., Addesso, P., Adhikari, R. X., Adya, V. B., Affeldt, C., Agathos, et al
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- **Simple, picojoule-sensitive ultraviolet autocorrelator based on two-photon conductivity in sapphire** *APPLIED OPTICS*
Leedle, K. J., Urbanek, K. E., Byer, R. L.
2017; 56 (8): 2226-2229
- **Exploring the sensitivity of next generation gravitational wave detectors** *CLASSICAL AND QUANTUM GRAVITY*
Abbott, B. P., Abbott, R., Abbott, T. D., ABERNATHY, M. R., Ackley, K., Adams, C., Addesso, P., Adhikari, R. X., Adya, V. B., Affeldt, C., Aggarwal, N., Aguiar, O. D., Ain, et al
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- **All-sky search for short gravitational-wave bursts in the first Advanced LIGO run** *PHYSICAL REVIEW D*
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- **Optical gating and streaking of free electrons with sub-optical cycle precision** *NATURE COMMUNICATIONS*
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- **The basic physics of the binary black hole merger GW150914** *ANNALEN DER PHYSIK*
Abbott, B. P., Abbott, R., Abbott, T. D., ABERNATHY, M. R., Acernese, F., Ackley, K., Adams, C., Adams, T., Addesso, P., Adhikari, R. X., Adya, V. B., Affeldt, C., Agathos, et al
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- **THE RATE OF BINARY BLACK HOLE MERGERS INFERRED FROM ADVANCED LIGO OBSERVATIONS SURROUNDING GW150914** *ASTROPHYSICAL JOURNAL LETTERS*
Abbott, B. P., Abbott, R., Abbott, T. D., ABERNATHY, M. R., Acernese, F., Ackley, K., Adams, C., Adams, T., Addesso, P., Adhikari, R. X., Adya, V. B., Affeldt, C., Agathos, et al
2016; 833 (1)
- **SUPPLEMENT: "THE RATE OF BINARY BLACK HOLE MERGERS INFERRED FROM ADVANCED LIGO OBSERVATIONS SURROUNDING GW150914" (2016, ApJL, 833, L1)** *ASTROPHYSICAL JOURNAL SUPPLEMENT SERIES*
Abbott, B. P., Abbott, R., Abbott, T. D., ABERNATHY, M. R., Acernese, F., Ackley, K., Adams, C., Adams, T., Addesso, P., Adhikari, R. X., Adya, V. B., Affeldt, C., Agathos, et al
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- **UPPER LIMITS ON THE RATES OF BINARY NEUTRON STAR AND NEUTRON STAR-BLACK HOLE MERGERS FROM ADVANCED LIGO'S FIRST OBSERVING RUN** *ASTROPHYSICAL JOURNAL LETTERS*
Abbott, B. P., Abbott, R., Abbott, T. D., ABERNATHY, M. R., Acernese, E., Ackley, K., Adams, C., Adams, T., Addesso, P., Adhikari, R. X., Adya, V. B., Affeldt, C., Agathos, et al
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- **Results of the deepest all-sky survey for continuous gravitational waves on LIGO S6 data running on the Einstein@Home volunteer distributed computing project** *PHYSICAL REVIEW D*
Abbott, B. P., Abbott, R., Abbott, T. D., ABERNATHY, M. R., Acernese, F., Ackley, K., Adams, C., Adams, T., Addesso, P., Adhikari, R. X., Adya, V. B., Affeldt, C., Agathos, et al

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- **First targeted search for gravitational-wave bursts from core-collapse supernovae in data of first-generation laser interferometer detectors** *PHYSICAL REVIEW D*
Abbott, B. P., Abbott, R., Abbott, T. D., ABERNATHY, M. R., Acernese, F., Ackley, K., Adams, C., Adams, T., Addesso, P., Adhikari, R. X., Adya, V. B., Affeldt, C., Agathos, et al
2016; 94 (10)
- **Binary Black Hole Mergers in the First Advanced LIGO Observing Run** *PHYSICAL REVIEW X*
Abbott, B. P., Abbott, R., Abbott, T. D., ABERNATHY, M. R., Acernese, F., Ackley, K., Adams, C., Adams, T., Addesso, P., Adhikari, R. X., Adya, V. B., Affeldt, C., Agathos, et al
2016; 6 (4)
- **Improved Analysis of GW150914 Using a Fully Spin-Precessing Waveform Model** *PHYSICAL REVIEW X*
Abbott, B. P., Abbott, R., Abbott, T. D., ABERNATHY, M. R., Acernese, F., Ackley, K., Adams, C., Adams, T., Addesso, P., Adhikari, R. X., Adya, V. B., Affeldt, C., Agathos, et al
2016; 6 (4)
- **Directly comparing GW150914 with numerical solutions of Einstein's equations for binary black hole coalescence** *PHYSICAL REVIEW D*
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