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RESEARCH INTERESTS

Gravitational wave astrophysics
Strong field gravity, numerically and analytically
Theoretical physics

EDUCATION

Ph. D. in Physics	Advisor: Kip Thorne	California Institute of Technology	1996-2003
B.A. in Astronomy	*summa cum laude*	Cornell University	1992-1996

POSITIONS

Rochester Institute of Technology	Assistant Professor	2014-
University of Wisconsin-Milwaukee Bradley Foundation Fellowship (2011-12)	Research Associate	2010-2014
Penn State University	Research Associate	2007-2010
Northwestern University	Postdoctoral Fellow	2003-2007
California Institute of Technology	Graduate student and Teaching assistant	1996-2002
Cornell University PIs: Profs. Shapiro and Teukolsky	Relativity visualization REU group	1995-1996

TEACHING AND MENTORING

Postdoc projects

- A. Williamson, RIT (arxiv:1709.03095)
  Systematic errors in measuring parameters of precessing BH binaries
- A. Lundgren, Syracuse University and AEI-Hannover, (PRD 86 4020,2013; arXiv:1304.3332; ...)
  Analytic waveforms for precessing BH-NS binaries
- L. Pekowsky and J. Healy (both with D. Shoemaker), Georgia Tech (PRD 88 4040, 2013+ ...)
  Interpreting simulations of BH-BH binaries
- E. Ochsner, U. Wisconsin-Milwaukee (PRD 86 4037, 2012)
  Analytic methods to reconstruct binary dynamics from outgoing radiation

Graduate student projects

- Matteo Breschi, Pisa (...)
  Inspiral-merger consistency tests of general relativity with higher modes in LIGO's O2 run
- Daniel Wysocki, RIT (arXiv:1709.01943)
  Inferring the distribution of merging binary BH masses and spins
- Jacob Lange, RIT *Parameter estimation via numerical relativity templates* (arxiv:1606.01262)
- D. Trifiro, Pisa (PRD 93 044071,2016 +...)
  Parameter estimation with post-Newtonian resonances
- P. Nepal, U. Wisconsin-Milwaukee (arxiv:1509.06581)
  Semianalytic Fisher matrix for precessing BH-NS binaries

- H. Qi (with P. Brady), U. Wisconsin-Milwaukee
  Probing strong-field gravity with galactic center orbits
- B. Farr (with E. Ochsner), Northwestern (PRD 89 102005, 2014 + ...)
  Parameter estimation of black hole-neutron star binaries
- D. Gerosa (with E. Berti, M. Kesden, U. Sperhake), U. Miss. (PRD 87 4028, 2013 +...)
  Post-Newtonian spin resonances enable unexpected compact binary astrophysics
- L. London (with D. Shoemaker, L. Pekowsky, J. Healy), Georgia Tech (PRD 87 4038, 2013+...)
  Investigating precessing binary black hole simulations
- H.S. Cho (with CH Lee, C. Kim, E. Ochsner), KISTI and UWM (PRD 87 2400, 2013+...)
  Impact of amplitude corrections and spin on parameter estimation for BH-NS binaries in LIGO
- D. Clausen (with R. Wade, R. Kopparapu), Pennsylvania State University (ApJ 746 186, 2012)
  Population synthesis of hot subdwarf binaries: hidden populations and new constraints

Undergraduate and MS research projects

- Ben Champion (2018–), RIT BS: Rapid Monte Carlo integration for GW parameter inference
- Matt Delfavero (2018–), RIT BS/MS: Gaussian process interpolation for GW parameter inference
- Monica Rizzo (2015–2018), RIT: Estimating the tidal deformability of neutron stars (GW170817)
- Thomas Kilmer (2016–2017), RIT: Subtracting astrophysical stochastic GW foregrounds
- Jackson Henry (2014–), RIT: Higher harmonics and parameter estimation of binary black holes
- Brandon Miller (2014-2015), RIT: Fast versus accurate inference of inspiral (PRD 92 4056, 2015)
- Z. Meeks (2011), Georgia Tech: Orientation-dependent emission from mergers (PRD 85,084003)
- C. Schmidt (2007-2008), Penn State: Metadata for numerical relativity waveforms.
- E. Damashek (2007), high school: Strong gravitational lensing close to binary black holes
- A. Saleem (2005-2006), Northwestern: Classify progenitors of merging compact binaries.
- J. Kaplan (2004), Northwestern: Spinup of black holes in binaries (ApJ 632 1035, 2005)
- R. O'Leary (2004-2006), Northwestern: Clusters (PRD 76 061504; ApJ 637 937)
- D. Jones (2003-2004), Northwestern: Prototype search code for gravitational waves.

Summer school lectures

- Caltech Gravitational Wave Astrophysics Summer school (2013)

Structured classroom

- *Professor* (RIT)
  Math 182, Project-based calculus II (Fall 2014)
  Statistics 435, Statistics of linear models (Spring 2015)
  Math 251, Probability and Statistics I (Fall 2015-2018; Spring 2018)
  Math 252, Probability and Statistics II (Spring 2017)
  Astro 611, Statistical methods for astrophysics (Spring 2016)
  Astro 831, Stellar evolution and environments (Spring 2018)
- *Instructor* (UWM)
  Astronomy 103, Survey of Astronomy (Spring 2012)
- *Guest lectures*
  Intro to Astronomy (UWM: P. Brady & P. Chang, Fall 2012)
  Galaxies and Cosmology (UWM: D. Erb, 2011)
  General relativity (Northwestern: F. Rasio, 2005; Penn State: D. Shoemaker, 2008)

- *Teaching assistant* (Caltech)
  Graduate-level courses:
  Physics 236, *General Relativity* (2000-2001; Lindblom)
  Physics 125/95, *Quantum Mechanics* (1999-2000)
  Physics 130, *Condensed Matter* (1997-1999; Roukes)
  Undergraduate-level courses:
  Physics 12, *Waves, Quantum Physics, and Statistical Mechanics* (1996-1997,2001-2002; Preskill)

KEY ACHIEVEMENTS (non-LVC)

- **Astrophysical interpretation of binary black holes from LIGO**
  - Framework to estimate LIGO source population distributions (Wysocki et al, 2018), as used in end-of-O2 LVC merger rate and mass+spin distribution estimates (Abbott et al 2018)
  - Comparison of BBH population to LIGO observations, suggesting BH natal spins are small and consistent with isolated binary evolution (Wysocki et al 2018)
  - Estimating BH natal kicks consistent with misalignment constraints for GW151226 (ROS et al 2017)
- **Parameter inference**
  - Framework to directly compare GW data to numerical relativity (Abbott et al 2016)
  - First embarrassingly-parallel strategy for inferring source parameters from gravitational waves (Pankow et al, 2015).
  - Developed an effective Fisher matrix to evaluate, represent, and communicate gravitational wave parameter measurement accuracy with the broader physics community (ROS et al. 2013).
- **Strong-field source modeling: Precession**
  - **Analytic two-spin precession**: Collaboration solved the two-spin post-Newtonian precession problem (Kesden et al 2015), including identifying a previously-unknown instability in spin-aligned binaries (Gerosa et al 2015)
  - First robust, closed-form model for precessing compact binaries (Lundgren and ROS, 2013).
  - Demonstrated the remnant of binary black hole merger seems to "precess" (ROS et al. 2013).
  - Identified time-dependent GW polarization as an observationally-accessible probe of strong-field gravity. Developed two analytically-tractable tools, a corotating frame (ROS et al. 2011,2012) and polarization projection (ROS et al. 2013) to infer source dynamics from outgoing gravitational waves.
  - First systematic demonstration that generic precessing black hole binaries resemble nonprecessing binaries, in a corotating frame (Pekowsky et al. 2013).
- **Astrophysics**
  - One of key teams showing pair-instability SN would introduce observationally-visible maximum mass feature in GW observations of BBH (Belczynski et al, A&A, 2016)
  - In team that predicted properties of first GW detection (Belczynski et al, Nature, 2016)
  - **Cluster vs field**: Argued that GW spin measurements could distinguish between the population of binary black holes formed in globular clusters versus isolated binaries (Mandel and ROS, 2010)
  - **Measuring parameters of binary formation models with GW**: First framework to constrain astrophysical processes via systematic comparison of GW and other observations to theoretical predictions.
    Proof of concept for binary evolution constraints (ROS et al, ApJ, 2008).
    Impact of cosmological star formation and metallicity history (ROS et al 2010)

Proof of concept for measuring the star formation history of the universe and trends in formation over cosmic time (ET design study, 2010)

Framework for efficiently exploring and constraining binary evolution models (ROS 2013)

– **Merger rates and astrophysics**: First extensive and systematic predictions for LIGO compact binary detection rates through isolated binary evolution (ROS et al, ApJ, 2008).

Systematically explored all known formation mechanisms, including interacting environments (O'Leary et al., 2006; Sadowski et al 2008; Fregeau et al 2006), binary pulsars (ROS and Kim, 2010), short GRBs (ROS et al. 2008ab,2010), and critically **low-metallicity star formation** (ROS et al. 2012, Dominik et al. 2010, 2012, 2013).

Body of work summarized as the "official" LIGO rate estimate (Abadie et al., CQG, 2010).

- First explored nongaussian beams and mirrors in gravitational wave detectors

PROFESSIONAL AFFILIATIONS AND SERVICE

- Member of the LIGO Scientific Collaboration (2000–);
  Co-chair of the Publications and Presentations Committee (2018–)
- Served as referee for Nature; Physical Review Letters; the Monthly Notices of the Royal Astronomical Society; the Astrophysical Journal (regular and letters); Astronomy and Astrophysics; Classical and Quantum Gravity; and the New Journal of Physics.
- Proposal review for NSF and NWO (Netherlands).
- Member of the American Physical Society (APS), the American Astronomical Society (AAS), and the International Astronomical Union (IAU)
- Midwest Relativity Meeting organizing committee (2013)

RESEARCH PUBLICATIONS

Publication count: 243 total, 84 non-LSC (via ADS)
h-index: 76 total, 36 non-LSC (via ADS)

Discovery of gravitational waves from coalescing binary black holes

1. B. Abbott et al. (The LIGO Scientific Collaboration and the Virgo Collaboration).
   Observation of Gravitational Waves from a Binary Black Hole Merger.
   Phys. Rev. Lett., 16:061102–+, February 2016a.
2. B. Abbott et al. (The LIGO Scientific Collaboration and the Virgo Collaboration).
   Properties of the binary black hole merger GW150914.
   Phys. Rev. Lett., 116:241102, Jun 2016b. (link).
3. B. Abbott et al. (The LIGO Scientific Collaboration and the Virgo Collaboration).
   Astrophysical Implications of the Binary Black-hole Merger GW150914.
   Astroph. J. Letters, 818:L22, February 2016c. (link).
4. B. Abbott et al. (The LIGO Scientific Collaboration and the Virgo Collaboration).
   The Rate of Binary Black Hole Mergers Inferred from Advanced LIGO Observations Surrounding GW150914.
   Astroph. J. Letters, 833:1, February 2016d. (link).
5. Supplement: The Rate of Binary Black Hole Mergers Inferred from Advanced LIGO Observations Surrounding GW150914.
   Astroph. J. Supp., 227:14, June 2016.
6. B. Abbott et al. (The LIGO Scientific Collaboration and the Virgo Collaboration).
   Directly comparing GW150914 with numerical solutions of Einstein's equations for binary black hole coalescence.
   Phys. Rev. D, 94:064035, June 2016e. (link).

7. B. Abbott et al. (The LIGO Scientific Collaboration and the Virgo Collaboration).
Improved analysis of GW150914 using a fully spin-precessing waveform model.
Phys. Rev. X, 6:041014, October 2016. (link).

8. B. Abbott et al. (The LIGO Scientific Collaboration and the Virgo Collaboration).
Tests of general relativity with GW150914.
Phys. Rev. Lett., 116:221101, May 2016a. (link).

9. B. Abbott et al. (The LIGO Scientific Collaboration and the Virgo Collaboration).
GW150914: First results from the search for binary black hole coalescence with Advanced LIGO.
Phys. Rev. D, 93(12):122003, June 2016b.

10. B. Abbott et al. (The LIGO Scientific Collaboration and the Virgo Collaboration).
Observing gravitational-wave transient GW150914 with minimal assumptions.
Phys. Rev. D, 93(12):122004, June 2016c.

11. B. Abbott et al. (The LIGO Scientific Collaboration and the Virgo Collaboration).
GW150914: Implications for the Stochastic Gravitational-Wave Background from Binary Black Holes.
Phys. Rev. Lett., 116(13):131102, April 2016d. (link).

12. B. Abbott et al. (The LIGO Scientific Collaboration and the Virgo Collaboration).
Localization and broadband follow-up of the gravitational-wave transient GW150914.
Astroph. J. Letters, 826:L13, July 2016e. (link).

13. B. Abbott et al. (ANTARES Collaboration, IceCube Collaboration, The LIGO Scientific Collaboration and the Virgo Collaboration).
High-energy neutrino follow-up search of the first Advanced LIGO gravitational wave event with IceCube and ANTARES .
Phys. Rev. D, 93:122010, Jun 2016. (link).

14. B.P. Abbott et al (The LIGO Scientific Collaboration and the Virgo Collaboration).
Characterization of transient noise in Advanced LIGO relevant to gravitational wave signal GW150914.
Classical and Quantum Gravity, 33(13):134001, July 2016. (link).

15. B. P. Abbott, R. Abbott, T. D. Abbott, M. R. Abernathy, F. Acernese, K. Ackley, C. Adams, T. Adams, P. Addesso, R. X. Adhikari, and et al.
GW150914: The Advanced LIGO Detectors in the Era of First Discoveries.
Phys. Rev. Lett., 116(13):131103, April 2016.

16. The LIGO Scientific Collaboration and the Virgo Collaboration.
Characterization of transient noise in Advanced LIGO relevant to gravitational wave signal GW150914.
CQG, 33(13):134001, 2016. (link).

17. B. Abbott et al. (The LIGO Scientific Collaboration and the Virgo Collaboration).
The basic physics of the binary black hole merger GW150914.
Annalen der Physik, October 2016. (link).

18. B. Abbott et al. (The LIGO Scientific Collaboration and the Virgo Collaboration).
GW151226: Observation of Gravitational Waves from a 22 Solar-mass Binary Black Hole Coalescence.
Phys. Rev. Lett., 116:241103, June 2016a.

19. B. Abbott et al. (The LIGO Scientific Collaboration and the Virgo Collaboration).
Binary black hole mergers in the First Advanced LIGO observing run.
Phys. Rev. X, 6:041015, October 2016b.
URL (link).

20. B. P. Abbott et al (The LIGO Scientific Collaboration and the Virgo Collaboration).
Upper limits on the rates of binary neutron star and neutron-star–black-hole mergers from Advanced LIGO's first observing run.
Astroph. J. Letters, 832:L21, December 2016. (link).

21. C. Biwer and et al.
Validating gravitational-wave detections: The Advanced LIGO hardware injection system.
Available as arXiv:1612.07864, December 2016.

22. The LIGO Scientific Collaboration, the Virgo Collaboration, B. P. Abbott, R. Abbott, T. D. Abbott, F. Acernese, K. Ackley, C. Adams, T. Adams, P. Addesso, R. X. Adhikari, V. B. Adya, and et al.
GW170814: A Three-Detector Observation of Gravitational Waves from a Binary Black Hole Coalescence.
Phys. Rev. Lett., 119(14):141101, October 2017a.

23. The LIGO Scientific Collaboration, the Virgo Collaboration, B. P. Abbott, R. Abbott, T. D. Abbott, F. Acernese, K. Ackley, C. Adams, T. Adams, P. Addesso, R. X. Adhikari, V. B. Adya, and et al.
GW170608: Observation of a 19 Solar-mass Binary Black Hole Coalescence.
Astroph. J. Letters, 851:L35, December 2017b.

24. The LIGO Scientific Collaboration, The Virgo Collaboration, B. P. Abbott, R. Abbott, T. D. Abbott, F. Acernese, K. Ackley, C. Adams, T. Adams, P. Addesso, and et al.
Compact Binary Mergers in the First and Second Observing Runs of Advanced LIGO and Advanced Virgo.
Available at https://dcc.ligo.org/LIGO-P1800307, 2018a.

25. The LIGO Scientific Collaboration, The Virgo Collaboration, B. P. Abbott, R. Abbott, T. D. Abbott, F. Acernese, K. Ackley, C. Adams, T. Adams, P. Addesso, and et al.
The Population of Binary Black Holes Following Advanced LIGO's Second Observing Run.
Available at https://dcc.ligo.org/LIGO-P1800324, 2018b.

Recent small collaboration results

26. D. Gerosa, A. Lima, E. Berti, U. Sperhake, M. Kesden, and **R. O'Shaughnessy**.
Wide precession: binary black-hole spins repeatedly oscillating from full alignment to full anti-alignment.
arxiv:1811.05979, 2018a. (link).

27. A. Jenkins, **R. O'Shaughnessy**, M. Sakellariadou, and D. Wysocki.
Anisotropies in the astrophysical gravitational-wave background: The impact of black hole distributions.
Submitted to PRL; available as 1810.13435, 2018. (link).

28. J. Healy, C. Lousto, Y Zlochower, J. Lange, and **R. O'Shaughnessy**.
The second rit binary black hole simulations catalog and its application to gravitational waves parameter estimation.
To be submitted to PRD; available at LIGO dcc P1800300, 2018a. (link).

29. D. Gerosa, E. Berti, **R. O'Shaughnessy**, K. Belczynski, M. Kesden, D. Wysocki, and W. Gladysz.
Spin orientations of merging black holes formed from the evolution of stellar binaries.
Phys. Rev. D, 98:084036, August 2018b. (link).

30. D. Wysocki, J. Lange, and **R. O'Shaughnessy**.
Reconstructing phenomenological distributions of compact binaries via gravitational wave observations.
Submitted to PRD (available as arxiv:1805.06442), May 2018a. (link).

31. J. Lange, **R. O'Shaughnessy**, and M. Rizzo.
Rapid and accurate parameter inference for coalescing, precessing compact binaries.
Submitted to PRD; available at arxiv:1805.10457, 2018.

32. M. W. Coughlin, T. Dietrich, Z. Doctor, D. Kasen, S. Coughlin, A. Jerkstrand, G. Leloudas, O. McBrien, B. D. Metzger, **R. O'Shaughnessy**, and S. J. Smartt.
Constraints on the neutron star equation of state from AT2017gfo using radiative transfer simulations.
MNRAS, 480:3871–3878, November 2018.

33. J. Healy, J. Lange, **R. O'Shaughnessy**, C. O. Lousto, M. Campanelli, A. R. Williamson, Y. Zlochower, J. Calderón Bustillo, J. A. Clark, C. Evans, D. Ferguson, S. Ghonge, K. Jani, B. Khamesra, P. Laguna, D. M. Shoemaker, M. Boyle, A. García, D. A. Hemberger, L. E. Kidder, P. Kumar, G. Lovelace, H. P. Pfeiffer, M. A. Scheel, and S. A. Teukolsky.

Targeted numerical simulations of binary black holes for GW170104.
Phys. Rev. D, 97(6):064027, March 2018b.

34. D. Wysocki, D. Gerosa, **R. O'Shaughnessy**, K. Belczynski, W. Gladysz, E. Berti, M. Kesden, and D. E. Holz.
Explaining LIGO's observations via isolated binary evolution with natal kicks.
Phys. Rev. D, 97(4):043014, February 2018b. (link).

35. A.R. Williamson, J. Lange, **R. O'Shaughnessy**, J. Clark, P. Kumar, J.C. Bustillo, and J. Veitch.
Inferring parameters of potentially rapidly precessing binary black holes: Systematic challenges for future graviational wave measurements.
Phys. Rev. D, 96:124041, December 2017.
URL (link).

36. S. Chakrabarti, P. Chang, **R. O'Shaughnessy**, A. M. Brooks, S. Shen, J. Bellovary, W. Gladysz, and C. Belczynski.
The Contribution of Outer H I Disks to the Merging Binary Black Hole Population.
Astroph. J. Letters, 850:L4, November 2017.

37. K. Belczynski, J. Klencki, G. Meynet, C. L. Fryer, D. A. Brown, M. Chruslinska, W. Gladysz, **R. O'Shaughnessy**, T. Bulik, E. Berti, D. E. Holz, D. Gerosa, M. Giersz, S. Ekstrom, C. Georgy, A. Askar, and J. P. Lasota.
Gw170104 and the origin of heavy, low-spin binary black holes via isolated classical binary evolution.
Submitted to Astron.& Astrophysics (arXiv:1706.07053), 2017. (link).

38. J. Lange, **R. O'Shaughnessy**, M. Boyle, J. Calderón Bustillo, M. Campanelli, T. Chu, J. A. Clark, N. Demos, H. Fong, J. Healy, D. A. Hemberger, I. Hinder, K. Jani, B. Khamesra, L. E. Kidder, P. Kumar, P. Laguna, C. O. Lousto, G. Lovelace, S. Ossokine, H. Pfeiffer, M. A. Scheel, D. M. Shoemaker, B. Szilagyi, S. Teukolsky, and Y. Zlochower.
Parameter estimation method that directly compares gravitational wave observations to numerical relativity.
Phys. Rev. D, 96(10):104041, November 2017.

39. R. O'Shaughnessy, G. Gerosa, and D. Wysocki.
Inferences about supernova physics from gravitational-wave measurements: GW151226 spin misalignment as an indicator of significant black-hole natal kick.
Phys. Rev. Lett., page 011101, Jul 2017. (link).

40. **R. O'Shaughnessy**, J. Blackman, and S. Field.
An architecture for efficient multimodal parameter estimation with linear surrogate models.
CQG, June 2017a. (link).

41. **R. O'Shaughnessy**, J. Bellovary, A. Brooks, S. Shen, F. Governato, and C. Christensen.
The effects of host galaxy properties on merging compact binaries detectable by ligo.
MNRAS, 464:2831–2839, August 2017b.
URL (link).

42. G. Lovelace, C. O. Lousto, J. Healy, M. A. Scheel, A. Garcia, **R. O'Shaughnessy**, M. Boyle, M. Campanelli, D. A. Hemberger, L. E. Kidder, H. P. Pfeiffer, B. Szilágyi, S. A. Teukolsky, and Y. Zlochower.
Modeling the source of GW150914 with targeted numerical-relativity simulations.
Classical and Quantum Gravity, 33(24):244002, December 2016. (link).

43. K. Belczynski, A. Heger, A. Ruiter, S. Woosley, G. Wiktorowicz, H.-Y. Chen, T. Bulik, **R. O'Shaughnessy**, D.E. Holz, C.L. Fryer, and E. Berti.
The Effect of Pair-Instability Mass Loss on Black Hole Mergers.
A&A, 594:A97, 2016a.

44. K. Belczynski, D. Holz, T. Bulik, and **R. O'Shaughnessy**.
The origin and evolution of LIGOs first gravitational-wave source.
Nature, 534:512, June 2016b.
URL (link).

45. K. Belczynski, S. Repetto, D. Holz, **R. O'Shaughnessy**, T. Bulik, E. Berti, C. Fryer, and M. Dominik.
Compact Binary Merger Rates: Comparison with LIGO/Virgo Upper Limits.
Astroph. J., 819:108, March 2016c. (link).

46. **R. O'Shaughnessy**, P. Nepal, and A. Lundgren.
A semianalytic fisher matrix for precessing bh-ns binaries.
Submitted to PRL (arXiv:1509.06581), 2015. (link).

47. D. Trifiro, **R. O'Shaughnessy**, D. Gerosa, E. Berti, M. Kesden, T. Littenberg, and U Sperhake.
Distinguishing black-hole spin-orbit resonances via gravitational waves II: Full parameter estimation.
Phys. Rev. D, 93:044071, Feb 2016. (link).

48. D. Gerosa, M. Kesden, **R. O'Shaughnessy**, A. Klein, E. Berti, U. Sperhake, and D. Trifiro.
Precessional instability in binary black holes with aligned spins.
Phys. Rev. Lett., 115:141102, Oct 2015a. (link).

49. B. Miller, **R. O'Shaughnessy**, B. Farr, and T. Littenberg.
Rapid gravitational wave parameter estimation with a single spin: Systematic uncertainties in parameter estimation with the SpinTaylorF2 approximation.
Phys. Rev. D, 92:4056, August 2015. (link).

50. D. Gerosa, M. Kesden, U. Sperhake, E. Berti, and **R. O'Shaughnessy**.
A multi-timescale analysis of phase transitions in precessing black-hole binaries.
Phys. Rev. D, 92:064016, Sep 2015b. (link).

51. C. Pankow, P. Brady, E. Ochsner, and **R. O'Shaughnessy**.
Novel scheme for rapid parallel parameter estimation of gravitational waves from compact binary coalescences.
Phys. Rev. D, 92(2):023002, July 2015. (link).

52. Michael Kesden, Davide Gerosa, **R. O'Shaughnessy**, E. Berti, and U. Sperhake.
Effective potentials and morphological transitions for binary black hole spin precession.
Phys. Rev. Lett., 114:081103, Feb 2015. (link).

53. J. Veitch, V. Raymond, B. Farr, W. M. Farr, P. Graff, S. Vitale, B. Aylott, K. Blackburn, N. Christensen, M. Coughlin, W. D. Pozzo, F. Feroz, J. Gair, C. Haster, V. Kalogera, T. Littenberg, I. Mandel, **R. O'Shaughnessy**, M. Pitkin, C. Rodriguez, C. Röver, T. Sidery, R. Smith, M. V. D. Sluys, A. Vecchio, W. Vousden, and L. Wade.
Robust parameter estimation for compact binaries with ground-based gravitational-wave observations using LALInference.
Phys. Rev. D, 91:042003, Feb 2015. (link).

54. M. Dominik, E. Berti, **R. O'Shaughnessy**, I. Mandel, K. Belczynski, C. Fryer, D. E. Holz, T. Bulik, and F. Pannarale.
Double Compact Objects III: Gravitational-wave Detection Rates.
Astroph. J., 806:263, June 2015. (link).

Multimessenger discovery of coalescing binary neutron stars

55. The LIGO Scientific Collaboration, the Virgo Collaboration, B. P. Abbott, R. Abbott, T. D. Abbott, F. Acernese, K. Ackley, C. Adams, T. Adams, P. Addesso, and et al.
GW170817: Observation of gravitational waves from a binary neutron star inspiral.
Phys. Rev. Lett., 119:161101, October 2017a.

56. The LIGO Scientific Collaboration, the Virgo Collaboration, B. P. Abbott, R. Abbott, T. D. Abbott, F. Acernese, K. Ackley, C. Adams, T. Adams, P. Addesso, and et al.
Multi-messenger Observations of a Binary Neutron Star Merger.
Astroph. J. Letters, October 2017b.

57. The LIGO Scientific Collaboration, the Virgo Collaboration, B. P. Abbott, R. Abbott, T. D. Abbott, F. Acernese, K. Ackley, C. Adams, T. Adams, P. Addesso, and et al.
Gravitational Waves and Gamma Rays from a Binary Neutron Star Merger: GW170817 and GRB

170817A.
Astroph. J. Letters, October 2017c.

58. The LIGO Scientific Collaboration, the Virgo Collaboration, B. P. Abbott, R. Abbott, T. D. Abbott, F. Acernese, K. Ackley, C. Adams, T. Adams, P. Addesso, and et al.
Estimating the Contribution of Dynamical Ejecta in the Kilonova Associated with GW170817.
Astroph. J. Letters, 850:L39, December 2017d.

59. The LIGO Scientific Collaboration, the Virgo Collaboration, B. P. Abbott, R. Abbott, T. D. Abbott, F. Acernese, K. Ackley, C. Adams, T. Adams, P. Addesso, and et al.
Search for Post-merger Gravitational Waves from the Remnant of the Binary Neutron Star Merger GW170817.
Astroph. J. Letters, 851:L16, December 2017e.

60. The LIGO Scientific Collaboration, the Virgo Collaboration, B. P. Abbott, R. Abbott, T. D. Abbott, F. Acernese, K. Ackley, C. Adams, T. Adams, P. Addesso, and et al.
A standard siren measurement of the Hubble constant.
Nature, 551:85–88, November 2017f.

61. The LIGO Scientific Collaboration, the Virgo Collaboration, B. P. Abbott, R. Abbott, T. D. Abbott, F. Acernese, K. Ackley, C. Adams, T. Adams, P. Addesso, and et al.
On the Progenitor of Binary Neutron Star Merger GW170817.
Astroph. J. Letters, 850:L40, October 2017g.

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Research supporting LIGO analysis of electromagnetic counterparts to GW events

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CONFERENCE PROCEEDINGS, REVIEW ARTICLES, AND DESIGN STUDIES

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145. B. Sathyaprakash, M. Abernathy, F. Acernese, P. Ajith, B. Allen, P. Amaro-Seoane, N. Andersson, S. Aoudia, K. Arun, P. Astone, and et al. Scientific objectives of Einstein Telescope. *Classical and Quantum Gravity*, 29(12):124013, June 2012.

146. R. A. Wade, D. R. Clausen, R. K. Kopparapu, R. O'Shaughnessy, M. A. Stark, and M. J. Walentosky. A Hidden Population of Hot Subdwarf Stars in Close Binaries. In V. Kologera & M. van der Sluys, editor, *American Institute of Physics Conference Series*, volume 1314 of *American Institute of Physics Conference Series*, pages 73–78, December 2010.

147. R. A. Wade, R. K. Kopparapu, and R. O'Shaughnessy. Testing Binary Population Synthesis Models with Hot Subdwarfs. In M. E. van Steenberg, G. Sonneborn, H. W. Moos, & W. P. Blair, editor, *American Institute of Physics Conference Series*, volume 1135 of *American Institute of Physics Conference Series*, pages 231–233, May 2009.

UNPUBLISHED TALKS AND SEMINARS

1. Reducing Thermoelastic Noise by Reshaping the Light Beams and Test Masses. *LIGO Scientific Collaboration general meeting*, August 2001.

2. Reducing thermoelastic noise in LIGO mirrors. *17th Pacific Coast Gravity Meeting, ITP, UC Santa Barbara*, March 2001.

3. Mexican Hat (Flat-Topped) Beams for Advanced LIGO. *LIGO Scientific Collaboration general meeting*, August 2003.

4. Constraints on binary black hole inspiral rates via population synthesis and binary neutron stars . *17th International Conference on General Relativity and Gravitation*, December 2004.

5. Population synthesis and binary black hole merger rates. *LIGO Scientific Collaboration general meeting*, August 2004.
6. Population synthesis and binary black hole merger rates. *Midwest Relativity Meeting*, October 2004.
7. Constraints on compact-object merger rates via (EM) NS-NS observations. *9th annual Gravitational Wave Data Analysis Workshop*, December 2004.
8. Phase steps: Nonparametric extensions to inspiral template families. *9th annual Gravitational Wave Data Analysis Workshop*, December 2004.
9. Expected compact-object merger rates. *LIGO Scientific Collaboration general meeting*, March 2005.
10. Black hole mergers via interactions in dense clusters **(Invited talk)**. *MODEST-6 Meeting, Northwestern University*, August 2005.
11. Delayed mergers: The contribution of ellipticals, globular clusters, and protoclusters to the LIGO detection rate. *LIGO Scientific Collaboration general meeting*, August 2005.
12. Updated merger rates BH-BH, BH-NS, NS-NS rates via best-constrained population synthesis. *LIGO Scientific Collaboration general meeting*, August 2005.
13. Binary models for short gamma ray bursts **(Invited talk)**. *New Views of the Universe, KICP Inaugural Symposium, Kavli Institute, Chicago*, December 2005.
14. Compact object merger rates. *10th annual Gravitational Wave Data Analysis Workshop*, December 2005.
15. Critically assessing Binary mergers as short hard GRBs **(Invited talk)** . *LIGO-Caltech*, March 2006.
16. Compact object merger rates: Predictions and Constraints (including short GRBs). *LIGO Scientific Collaboration general meeting*, March 2006.
17. Detecting binary mergers with gravitational waves (or, *Why LIGO is needed to understand short GRBs*) **(Invited talk)**. *Argonne National Lab, High Energy Physics/Astrophysics seminar*, November 2006.
18. Constraining binary evolution with event rates: Predicted merger rates of and astrophysical constraints on BH-NS and NS-NS mergers, including short GRBs. *23rd Texas Symposium, Melbourne, Australia*, December 2006.
19. Gravitational wave astronomy: A new window on the universe **(Invited talk)**. *Georgia Tech Physics Colloquium, Atlanta, GA*, January 2007.
20. Astrophysical constraints on BH-NS and NS-NS mergers and the short GRB redshift distribution **(Invited talk)**. *KICP Lunch Colloquium, Chicago, IL*, February 2007.
21. Astrophysical constraints on BH-NS and NS-NS mergers and the short GRB redshift distribution **(Invited talk)**. *UIUC Physics Colloqium, Champaign, IL*, 2007.
22. Comparing the known (astrophysical constraints on BH-NS and NS-NS mergers) and the unknown (short GRBs) **(Invited talk)**. *Ringberg short GRB workshop, Munich, Germany*, 2007.
23. Unravelling short GRBs with LIGO, Swift, and GLAST. *Argonne GLAST workshope, Argonne National Lab, Chicago, USA*, 2007.
24. Short GRBs and Mergers: Astrophysical constraints on a BH-NS and NS-NS origin. *APS, Jacksonville, USA*, 2007.
25. Short GRBs and Mergers: Astrophysical constraints on a BH-NS and NS-NS origin. *Penn State University, USA*, May 2007.
26. The probability of compact binary coalescence detection with enhanced LIGO. *Boston, MA*, December 2007.
27. Can short GRBs be NS mergers? *APS April meeting*, April 2008.
28. Astrophysics with LIGO **(Invited talk)**. *Columbia University Particle Physics Seminar*, 2008.
29. Astrophysics with LIGO: Constraining binary populations. *East Coast Gravity Meeting*, May 2008.

30. Ground-based gravitational-wave astronomy and compact objects in clusters **(Invited talk)**. *UCSB KITP globular cluster program*, 2009.

31. Astrophysics with gravitational-wave measurements of binary compact object mass distributions. *APS April Meeting*, May 2009.

32. Gravitational wave emission from (short) GRBs **(Invited talk)**. *Multi-messenger astrophysics conference: Center for relativistic astrophysics, Georgia Tech*, May 2009.

33. Gravitational wave signatures of binary evolution **(Invited talk)** . *Syracuse university gravitational wave group*, May 2009.

34. Astrophysics with gravitational-wave measurements of binary compact object mass distributions. *8th Amaldi meeting*, May 2009.

35. Binary neutron star astrophysics **(Invited talk)**. *Numerical relativity and data analysis conference; AEI, Potsdam*, 2009.

36. Opening a new window on the universe: Gravitational wave astronomy with compact binaries **(Invited talk)**. *TAMU Commerce, Commerce, TX*, 2010.

37. Using short GRBs to limit birefringence in Chern-Simons modified gravity. *Workshop on gravitational wave tests of alternative theories of gravity in the advanced detector era; UWM, Milwaukee*, May 2010.

38. Testing GR using Externally Triggered Searches: Astrophysical challenges. *Workshop on gravitational wave tests of alternative theories of gravity in the advanced detector era; UWM, Milwaukee*, May 2010.

39. Selection biases of nonspinning searches for spinning binaries in ground-based detector data. *Midwest relativity meeting; Guelph, Canada*, November 2010.

40. Choosing precessing black hole binary simulations that cover the waveform space. *APS April Meeting; Anaheim, CA*, 2011.

41. Microphysics to macrophysics: Astrophysics and gravitational wave science targets in the advanced detector era and beyond. *Microphysics in Computational Relativistic Astrophysics: 2011; Perimeter Institute*, 2011.

42. Low metallicity star formation: a nursery for compact binary mergers? (**Invited talks**). *Perimeter and CITA, Toronto*, October 2011.

43. Low metallicity star formation: a nursery for compact binary mergers? **(Invited talk)**. *Center for Relativistic Astrophysics, Georgia Tech*, February 2012.

44. Distinguishing between merging black hole binaries, with orientation-dependent emission. *APS April Meeting; Atlanta, GA*, April 2012.

45. Gravitational wave source populations **(Invited talk)**. *Connecting the Gravitational Wave and Electromagnetic Skies in the Era of Advanced LIGO, Princeton, NJ*, May 2012.

46. Precession during merger: Strong polarization changes are observationally accessible features of strong-field gravity during binary black hole merger. *Rattle and Shine: Gravitational Wave and Electromagnetic Studies of Compact Binary Mergers, KITP, Santa Barbara [July]; and Midwest Relativity Meeting, Chicago, IL [Sept]*, July 2012.

47. Gravitational wave astronomy of merging compact binaries **(Invited talk)**. *Workshop on Outstanding Problems in Massive Star Research – the final stages; St. Paul, MN*, October 2012.

48. Interpreting the complex gravitational wave symphony from merging, precessing black hole binaries. *Physics colloquium, Department of Physics, U. of Mississippi* **(Invited talk)**, November 2012.

49. Low metallicity star formation: a nursery for compact binary mergers? *Theoretical Astrophysics and Relativity Seminar, Caltech*, January 2013.

50. Gravitational wave astrophysics with merging compact binaries **(Invited talk)**. *Theoretical astrophysics seminar, U. Illinois (Urbana)*, February 2013.

51. Interpreting the complex gravitational wave symphony from merging, precessing black hole binaries (**Invited talk)**. *Princeton [March] and RIT [June]*, March 2013.

52. Using a corotating frame to model and interpret gravitational waves from strong-field binary black hole merger. *APS Meeting, Denver, CO*, April 2013.
53. Gravitational wave source populations. *Caltech Gravitational Wave Astrophysics summer school*, July 2013.
54. A closed-form model for gravitational waves from precessing BH-NS binaries. *23rd Midwest Relativity Meeting, Milwaukee, WI*, October 2013.
55. Disentangling astrophysics from gravity. *Testing General Relativity with Astrophysical Observations, Oxford MS*, January 2014.
56. Astrophysical inferences from gravitational wave detections. *SMS colloquium, Rochester Institute of Technology [February]; Physics colloquium, U. Mississippi [March]*, 2014.
57. Estimating parameters of BH-NS binaries with gravitational waves. *APS April meeting, Savanna, GA*, April 2014.
58. Efficient high-mass parameter estimation. *NARDA 2014, Fullerton, CA*, August 2014.
59. Understanding and evolving precessing black hole binaries. *Aspen Center for Physics*, January 2015.
60. A semianalytic Fisher matrix for precessing BH-NS binaries. *APS April Meeting, Baltimore, MD*, April 2015.
61. Efficient high-mass parameter estimation. *Cornell University relativity seminar, Ithaca, NY*, May 2015.
62. Efficient high-mass parameter estimation. *2015 East Coast Gravity Meeting, Rochester, NY*, May 2015.
63. New perspectives on the dynamics of precessing binary black holes. *CITA (U. Toronto)*, October 2015.
64. GR@100++: Beyond Gravitational Wave Detection (invited panelist). *Princeton University, Center for Theoretical Science*, April 2016.
65. Directly comparing GW150914 with Numerical Relativity. *APS April Meeting, Salt Lake City*, April 2016.
66. Directly comparing GW150914 with Numerical Relativity. *Gravitational Wave Physics and Astronomy Workshop*, July 2016.
67. Will LIGO infer formation scenarios of binary BH mergers **(Invited talk)**. *KITP Rapid Response Workshop: Astrophysics from LIGO's First Black Holes*, August 2016.
68. Data analysis for the future (Roundtable). *GW161212: The Universe through gravitational waves, Simons Center for Geometry and Physics, Stony Brook NY*, December 2016.
69. An architecture for efficient multimodal parameter estimation with linear surrogate models. *APS April Meeting, Washington DC*, January 2017.
70. Numerical relativity and gw data. *The Dawning Era of Gravitational-Wave Astrophysics, Aspen Center for Physics*, January 2017.
71. Measuring the imprint of spin in the strong field. *Strong Gravity and Binary Dynamics*, February 2017.
72. Inferences about supernova physics from gravitational-wave measurements of gw151226. June 2017.
73. How much does galaxy assembly history impact the population of merging compact binaries? (**Invited talk**). *Texas Tech University*, June 2017.
74. Forming ligos merging bh-bh binaries via isolated binary evolution. *Aspen Center for Physics*, July 2017.
75. Gravitational waves: opening a new window on the universe. November 2017.
76. Compact object astrophysics and gravitational wave astronomy (**invited talk**). *NY section APS meeting*, November 2017.

77. Inferring tidal distortion of coalescing neutron star binaries. *231st American Astronomical Society Meeting, Washington DC*, January 2018.

78. Constraining the nuclear equation of state with multiple observational channels. *April APS meeting, Columbus OH*, April 2018.

AWARDS AND HONORS

Bruno Rossi Prize (2017, with Gaby Gonzalez as part of the LIGO Scientific Collaboration)
Princess of Asturias Award for Scientific and Technical Research (2017, as part of the LIGO Scientific Collaboration)
Einstein Medal (2017, as part of the LIGO Scientific Collaboration)
Special Breakthrough Prize in Fundamental Physics (2016, as part of the LIGO Scientific Collaboration)
2016 Gruber Cosmology Prize (as part of the LIGO Scientific Collaboration)