

Carl Rodriguez | Curriculum Vitae

Department of Physics – Carnegie Mellon University – Pittsburgh, PA

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Education and Employment

Carnegie Mellon University <i>Pittsburgh, PA</i> Assistant Professor of Physics	Professor 2020-Present
Harvard University <i>Cambridge, MA</i> ITC Postdoctoral Fellow	Postdoc 2019-2020
Massachusetts Institute of Technology <i>Cambridge, MA</i> Pappalardo Postdoctoral Fellow	Postdoc 2016-2019
Northwestern University <i>Evanston, IL</i> Thesis – Modeling Dense Star Clusters and Their Implications for Advanced LIGO Advisor – Frederic Rasio	Ph.D. Physics 2010-2016
Reed College <i>Portland, OR</i> Thesis – Accretion Disk Geodesics in Extreme Kerr Geometries Advisor – Joel Franklin	B.A. Physics 2006-2010

Honors, Awards, and Fellowships

○ ITC Fellowship, Harvard University	2019-2020
○ MIT Spot Award	2017
○ MIT Pappalardo Fellowship	2016-2019
○ NSF Graduate Research Fellowship	2011-2016
○ NSF GK12 Fellowship	2013-2014
○ Illinois Space Grant Consortium Fellowship	2010-2011, 2015-2016
○ NSF STEM Scholar	2008-2010

Grants And Proposals

WoU-MMA: The Evolution, Destruction, and Gravitational-wave Sources of Dense Star Clusters in Cosmological Simulations <i>PI: C. L. Rodriguez; NSF Award AST-2009916 (\$434,393)</i>	NSF-AST 2020
Astrophysics and Cyberinfrastructure Initiatives for Decihertz Gravitational-Wave Missions <i>PI: A. Miguel Holgado, co-I: C. L. Rodriguez; McWilliams Seed Grant (\$10,000)</i>	CMU Grant 2020
Modeling Dense Star Clusters and their Gravitational-wave Sources from Cosmological Simulations <i>PI: C. L. Rodriguez, Co-I: Astrid Lamberts, Mike Grudić; 1.1M CPU Hours (\$20,140 Value)</i>	XSEDE 2018

Publications (with links)

A complete list of publications can also be found at the NASA ADS service [here](#).

As of June 2020:

- All Publications (excluding collaboration papers) – 2489 citations, h-index of 27
- First-Author Publications – 1193 citations, h-index of 13

First Author Papers.....

- GW190412 as a Third-Generation Black Hole Merger from a Super Star Cluster** **ApJL**
C. L. Rodriguez, K. Kremer, M. Grudić, Z. Hafen, S. Chatterjee, G. Fragione, A. Lamberts, M. Martinez, F. Rasio, N. Weatherford, S. Ye; *Astrophys. J. Lett.*, **896**, L10
2020
- Black Holes: The Next Generation – Repeated Mergers in Dense Star Clusters and their Gravitational-Wave Properties** **PRD**
C. L. Rodriguez, M. Zevin, P. Amaro-Seoane, S. Chatterjee, K. Kremer, F. Rasio, S. Ye; *Phys. Rev. D*, **100**, 043027
2019
- Post-Newtonian Dynamics in Dense Star Clusters: Formation, Masses, and Merger Rates of Highly-Eccentric Black Hole Mergers** **PRD**
C. L. Rodriguez, P. Amaro-Seoane, S. Chatterjee, K. Kremer, F. Rasio, J. Samsing, S. Ye, M. Zevin; *Phys. Rev. D*, **98**, 123005
2018
- Redshift Evolution of the Black Hole Merger Rate From Globular Clusters** **ApJL**
C. L. Rodriguez, A. Loeb; *Astrophys. J.*, **865**, L5
2018
- A Triple Origin for the Heavy and Low-Spin Binary Black Holes Detected by LIGO/Virgo** **ApJ**
C. L. Rodriguez, F. Antonini; *Astrophys. J.*, **963**, 1, 7
2018
- A New Hybrid Technique for Modeling Dense Star Clusters** **CompAC**
C. L. Rodriguez, B. Pattabiraman, S. Chatterjee, M. Morscher, F. Rasio, A. Choudhary, W-K. Liao; *Computational Astrophysics and Cosmology*, **5**, 1
2018
- Post-Newtonian Dynamics in Dense Star Clusters: Highly-Eccentric, Highly-Spinning, and Repeated Binary Black Hole Mergers** **PRL**
C. L. Rodriguez, P. Amaro-Seoane, S. Chatterjee, F. Rasio; *Phys. Rev. Lett.*, **120**, 151101
2018
- Articles in *Boston Globe*, *MIT News* (Links),
- Illuminating Black Hole Binary Formation Channels with Spins in Advanced LIGO** **ApJL**
C. L. Rodriguez, M. Zevin, C. Pankow, V. Kalogera, F. Rasio; *Astrophys. J. Lett.*, **832**, L2
2016
- Dynamical Formation of the GW150914 Binary Black Hole** **ApJL**
C. L. Rodriguez, C.-J. Haster, S. Chatterjee, V. Kalogera, F. Rasio; *Astrophys. J. Lett.*, **824**, L8
2016
- Articles in *New Scientist*, *Sky News* (Links),
- Synopsis in *Astrobites* (Link)
- Binary Black Hole Mergers from Globular Clusters: Masses, Merger Rates, and the Impact of Stellar Evolution** **PRD**
C. L. Rodriguez, S. Chatterjee, F. Rasio; *Phys. Rev. D*, **93**, 084029
2016
- Million-Body Star Cluster Simulations: Comparisons between Monte Carlo and Direct N -body** **MNRAS**
C. L. Rodriguez, M. Morscher, L. Wang, S. Chatterjee, F. Rasio, R. Spurzem; *Mon. Not. R. Astron. Soc.* **463**, 2109
2016

Binary Black Hole Mergers from Globular Clusters: Implications for Advanced LIGO **PRL**
2015
C. L. Rodriguez, M. Morscher, B. Pattabiraman, S. Chatterjee, C.J. Haster, and F. Rasio;
 Phys. Rev. Lett. **115**, 051101
 - Synopsis by APS in *Physics* (Link)
 - Synopsis in popular science blog *IFLS* (Link)

Basic Parameter Estimation of Binary Neutron Star Systems by the Advanced LIGO/Virgo Network **ApJ**
2014
C. L. Rodriguez, B. Farr, V. Raymond, W. Farr, T. Littenberg, D. Fazi, V. Kalogera;
 Astrophys. J., **785**, 2, 119

Inadequacies of the Fisher Information Matrix in gravitational-wave parameter estimation **PRD**
2013
C. L. Rodriguez, B. Farr, W. Farr, I. Mandel; Phys. Rev. D, **88**, 8, 084013

Verifying the no-hair property of massive compact objects with intermediate-mass-ratio inspirals in advanced gravitational-wave detectors **PRD**
2012
C. L. Rodriguez, I. Mandel, J. Gair; Phys. Rev. D, **85**, 6, 062002
 - Synopsis in *Astrobitess* (Link)

Second Author Papers.....

Relativistic Three-body Effects in Hierarchical Triples 2020
H. Lim, C. L. Rodriguez; Phys. Rev. D (submitted)

Post-Newtonian Dynamics in Dense Star Clusters: Binary Black Holes in the LISA Band **PRD**
2019
K. Kremer, C. L. Rodriguez, P. Amaro-Seoane, K. Breivik, S. Chatterjee, M. Katz, S. Larson, F. Rasio, J. Samsing, S. Ye, M. Zevin; Phys. Rev. D , **99**, 063003

Precessional Dynamics of Black Hole Triples: Binary Mergers with near-zero Effective Spin **MNRASL**
2018
F. Antonini, C. L. Rodriguez, C. Petrovich, C. Fischer; Mon. Not. R. Astron. Soc. Lett., **480**, 1, L58

Binary Black Holes in Dense Star Clusters: Exploring the Theoretical Uncertainties **ApJ**
2017
S. Chatterjee, C. L. Rodriguez, F. Rasio; Astrophys. J., **834**, 1, 68

Dynamical Formation of Low-mass Merging Black Hole Binaries like GW151226 **ApJL**
2017
S. Chatterjee, C. L. Rodriguez, V. Kalogera, F. Rasio; ApJL, **836**, L26

Distinguishing Between Formation Channels for Binary Black Holes with LISA **ApJL**
2016
K. Breivik, C. L. Rodriguez, S. Larson, V. Kalogera, F. Rasio; Astrophys. J. Lett., **830**, L18

Contributing Author Papers.....

Measuring the Star Formation Rate with Gravitational Waves from Binary Black Holes **ApJL**
2018
S. Vitale, W. Farr, K. Ng, C. L. Rodriguez; Astrophys. J. Lett., **886**, 1

On the Rate of Neutron Star Binary Mergers from Globular Clusters **ApJL**
2020
C. Ye, W.-F. Fong, K. Kremer, C. L. Rodriguez, S. Chatterjee, G. Fragione, F. Rasio; Astrophys. J. Lett., **888**, 10

Gravitational-wave Captures of Single Black Holes in Globular Clusters 2019
J. Samsing, D. D’Orazio, K. Kremer, C. L. Rodriguez, A. Askar; Phys. Rev. D (submitted)

COSMIC Variance in Binary Population Synthesis 2019
K. Breivik, S. Coughlin, M. Zevin, C. L. Rodriguez, K. Kremer, C. Ye, J. Andrews, M. Kurkowski, M. Digman, S. Larson, F. Rasio; Astrophys. J. (submitted)

Millisecond Pulsars and Black Holes in Globular Clusters **ApJ** 2019
C. Ye, K. Kremer, S. Chatterjee, C. L. Rodriguez, F. Rasio; Astrophys. J. , 877, 122

The fate of binaries in the Galactic Center: The Mundane and the Exotic **ApJ** 2019
S. Alexander, S. Naoz, A. Ghez, M. Morris, A. Ciurlo, T. Do, K. Breivik, S. Coughlin, C. L. Rodriguez; Astrophys. J. , 878, 58S

Eccentric Black Hole Mergers in Dense Star Clusters: The Role of Binary-Binary Encounters **ApJ** 2018
M. Zevin, J. Samsing, C. L. Rodriguez, C. Haster, E. Ramirez-Ruiz; Astrophys. J. , 871, 1

Predicting Stellar-mass Black Hole Populations in Globular Clusters **ApJ** 2018
N. Weatherford, S. Chatterjee, C. L. Rodriguez, F. Rasio; Astrophys. J. , 864, 13

How initial size governs core collapse in globular clusters **ApJ** 2018
K. Kremer, S. Chatterjee, C. Ye, C. L. Rodriguez, F. Rasio; Astrophys. J. , 871, 38

LISA Sources in Milky Way Globular Clusters **PRL** 2018
K. Kremer, S. Chatterjee, K. Breivik, C. L. Rodriguez, S. Larson, F. Rasio; PRL, 120, 19

How Black Holes Shape Globular Clusters: Modeling NGC 3201 **ApJL** 2018
K. Kremer, C. Ye, S. Chatterjee, C. L. Rodriguez, F. Rasio; Astrophys. J. Lett., 855, 15

Low-mass X-ray binaries ejected from globular clusters 2018
K. Kremer, S. Chatterjee, C. L. Rodriguez, F. Rasio; Astrophys. J. (submitted)

Accreting Black Hole Binaries in Globular Clusters **ApJ** 2017
K. Kremer, S. Chatterjee, C. L. Rodriguez, F. Rasio; Astrophys. J., 852, 29

Constraining Models of Binary Black Hole Formation with Gravitational-Wave Observations **ApJ** 2017
M. Zevin, C. Pankow, C. L. Rodriguez, L. Sampson, E. Chase, V. Kalogera, F. Rasio; Astrophys. J., 846, 82Z

Black Hole Mergers and Blue Stragglers from Hierarchical Triples Formed in Globular Clusters **ApJ** 2016
F. Antonini, S. Chatterjee, C. L. Rodriguez, M. Morscher, B. Pattabiraman, V. Kalogera, F. Rasio; Astrophys. J., 816, 2, 65

The Dynamical Evolution of Stellar Black Holes in Globular Clusters **ApJ** 2015
M. Morscher, B. Pattabiraman, C. L. Rodriguez, F. Rasio, S. Umbreit; Astrophys. J., 800, 1, 21

Parameter estimation for compact binaries with ground-based gravitational-wave observations using the LALInference software library **PRD** 2015
J. Veitch, V. Raymond, B. Farr, W. Farr, P. Graff, S. Vitale, B. Aylott, K. Blackburn, N. Christensen, M. Coughlin, W. Del Pozzo, F. Feroz, J. Gair, C.J. Haster, V. Kalogera, T. Littenberg, I. Mandel, R. O'Shaughnessy, M. Pitkin, C. L. Rodriguez, C. Röver, T. Sidery, R. Smith, M. Van Der Sluys, A. Vecchio, W. Vousden, L. Wade; Phys. Rev. D, 91, 4, 042003

Comparison of Gravitational Wave Detector Network Sky Localization Approximations **PRD** 2014
K. Grover, S. Fairhurst, B. Farr, I. Mandel, C. L. Rodriguez, T. Sidery, A. Vecchio; Phys. Rev. D, 89, 4, 042004

- Estimating parameters of coalescing compact binaries with proposed advanced detector networks** **PRD**
2012
J. Veitch, I. Mandel, B. Aylott, B. Farr, V. Raymond, C. L. Rodriguez, M. van der Sluys, V. Kalogera, A. Vecchio; Phys. Rev. D **85**, 104045
- Mock data challenge for the Einstein Gravitational-Wave Telescope** **PRD**
2012
T. Regimbau, T. Dent, W. Del Pozzo, S. Giampanis, T.G.F. Li, C. Robinson, C. Van Den Broeck, D. Meacher, C. L. Rodriguez, B.S. Sathyaprakash, K. Wójcik; Phys. Rev. D **86**, 122001
- Lateral alignment of InGaAs quantum dots as function of spacer thickness** **APL**
2009
Z. Wang, C. L. Rodriguez, S. Seydmohamadi, Y. I. Mazur, G. Salamo; Appl. Phys. Lett. **94**, 083107
- Controlling fluorescence intermittency of a single colloidal CdSe/ZnS quantum dot in a half cavity** **PRB**
2008
Y. Zhang, V. Komarala, C. L. Rodriguez, M. Xiao; Phys. Rev. B **78**, 241301(R)

Collaboration Papers.....

Coauthor on 23 Collaboration Papers as Member of LIGO Scientific Collaboration
 Click ([Here](#)) for Full List of Citations 2011-2015

- Characterization of the LIGO detectors during their sixth science run
- Searching for stochastic gravitational waves using data from the two colocated LIGO Hanford detectors
- Constraints on Cosmic Strings from the LIGO-Virgo Gravitational-Wave Detectors
- Application of a Hough search for continuous gravitational waves on data from the fifth LIGO science run
- Gravitational Waves from Known Pulsars: Results from the Initial Detector Era
- First Searches for Optical Counterparts to Gravitational-wave Candidate Events
- Search for long-lived gravitational-wave transients coincident with long gamma-ray bursts
- Directed search for continuous gravitational waves from the Galactic center
- Parameter estimation for compact binary coalescence signals with the first generation gravitational-wave detector network
- A first search for coincident gravitational waves and high energy neutrinos using LIGO, Virgo and ANTARES data from 2007
- Einstein@Home all-sky search for periodic gravitational waves in LIGO S5 data
- Search for gravitational waves from binary black hole inspiral, merger, and ringdown in LIGO-Virgo data from 2009-2010
- Swift Follow-up Observations of Candidate Gravitational-wave Transient Events
- Search for Gravitational Waves Associated with Gamma-Ray Bursts during LIGO Science Run 6 and Virgo Science Runs 2 and 3
- The characterization of Virgo data and its impact on gravitational-wave searches
- All-sky search for gravitational-wave bursts in the second joint LIGO-Virgo run
- Upper limits on a stochastic gravitational-wave background using LIGO and Virgo interferometers at 600-1000 Hz
- Search for gravitational waves from intermediate mass binary black holes
- First low-latency LIGO+Virgo search for binary inspirals and their electromagnetic counterparts
- Search for gravitational waves from low mass compact binary coalescence in LIGO's sixth science run and Virgo's science runs 2 and 3
- Implementation and testing of the first prompt search for gravitational wave transients with electromagnetic counterparts

- All-sky search for periodic gravitational waves in the full S5 LIGO data
- A gravitational wave observatory operating beyond the quantum shot-noise limit

Invited Talks/Seminars

YITP Black Holes and Neutron Stars with Gravitational Waves <i>Kyoto, Japan</i>	Invited Talk 2019
KITP Merging Visions: Exploring Compact-Object Binaries with Gravity and Light <i>Santa Barbara, CO</i>	Invited Talk 2019
University of Colorado Astronomy and Planetary Science Colloquium <i>Boulder, CO</i>	Colloquium 2019
UCLA Astrophysics Colloquium <i>Los Angeles, CA</i>	Colloquium 2019
Vanderbilt Physics Colloquium <i>Nashville, TN</i>	Colloquium 2019
Syracuse Physics Colloquium <i>Syracuse, NY</i>	Colloquium 2019
Carnegie-Mellon Astrophysics Colloquium <i>Pittsburgh, PA</i>	Colloquium 2019
UIUC Gravitation Seminar <i>Urbana-Champaign, IL</i>	Seminar 2019
UIUC Astronomy Colloquium <i>Urbana-Champaign, IL</i>	Colloquium 2018
Perimeter Institute Strong Gravity Seminar <i>Waterloo, Canada</i>	Seminar 2018
Stanford KIPAC Cosmology Seminar <i>Palo Alto, CA</i>	Seminar 2018
University of Cambridge IoA Galaxy Discussion <i>Cambridge, UK</i>	Seminar 2018
University of Surrey Astrophysics Seminar <i>Guildford, UK</i>	Seminar 2018
Harvard CfA Galaxy and Cosmology Seminar <i>Cambridge, MA</i>	Seminar 2018
CalTech Astronomy Colloquium <i>Pasadena, CA</i>	Colloquium 2018
Harvard Particle Theory Seminar <i>Cambridge, MA</i>	Seminar 2018
Columbia Astrophysics Colloquium <i>New York, NY</i>	Colloquium 2017

Harvard ITC Lunch Seminar <i>Cambridge, MA (Link)</i>	Seminar 2017
Strong Gravity and Binary Dynamics with Gravitational Wave Observations <i>Oxford, MS</i>	Invited Talk 2017
UCSC Flash Seminar <i>Santa Cruz, CA</i>	Seminar 2017
April APS Meeting <i>Washington, DC</i>	Invited Talk 2017
JSI Fall Workshop: Astrophysics in the Era of Grav. Wave Observations <i>Annapolis, MD</i>	Invited Talk 2016
KITP Rapid Response Workshop on Gravitational Waves <i>Santa Barbara, CA</i>	Invited Talk 2016
Compton Lecture Series <i>Chicago, IL (Link)</i>	Guest Seminar 2016
Stellar N-body Conference <i>Sexten, Italy</i>	Invited Talk 2014
Georgia Tech Center for Relativistic Astrophysics <i>Atlanta, GA</i>	Seminar 2011

Contributed Talks/Posters

Black Holes, Neutron Stars, and Gravitational Waves: The New Era of Multi-Messenger Astronomy <i>Honolulu, HI</i>	Chair 2019
- Proposed, chaired, and spoke at session at SACNAS (national conference for diversity in STEM)	
Triple Evolution and Dynamics Trendy-2 <i>Leiden, Netherlands</i>	Talk 2018
Aspen Center for Physics: Dawning Era of Gravitational-Wave Astrophysics <i>Aspen, CO</i>	Talk 2017
APS Meeting <i>Salt Lake City, UT</i>	Talk 2016
Midwest Relativity Meeting <i>Evanston, IL</i>	Talk 2015
April APS Meeting <i>Baltimore, MD</i>	Talk 2015
IAU Meeting <i>Beijing, China</i>	Talk 2014
AAS Head Meeting <i>Chicago, IL</i>	Poster 2014
LIGO Scientific Collaboration Meeting <i>Bethesda, MD</i>	Talk 2013
Midwest Relativity Meeting <i>Chicago, IL</i>	Talk 2012

Gravitational-Wave Physics and Astronomy Workshop <i>Hannover, Germany</i> - 3rd place award for best poster	Poster 2012
Gravitational-Wave Burst Workshop <i>Tobermory, Scotland</i>	Talk 2012
Midwest Relativity Meeting <i>Urbana, IL</i>	Talk 2011
Gravitational-Wave Physics and Astronomy Workshop <i>Milwaukee, WI</i>	Talk 2011

Public Lectures

MIT Independent Activities Period <i>The era of Gravitational-wave Astronomy; Cambridge, MA</i>	Public Talk 2017, 2018
Compton Lecture Series <i>Dense Star Clusters as Binary Black Hole Factories (Link)</i> Chicago, IL	Guest Seminar 2016
TEDxNorthwesternU <i>Listening to Einstein's Final Symphony (Link)</i> Evanston, IL	TEDx Talk 2016
Conversations with an Astronomer Series of Public Lectures at Adler Planetarium Chicago, IL	Lecture Series 2011–2016
Film Submission: Jackson Hole Science Media Festival <i>Black Holes and Globular Clusters (Link)</i>	Short Film 2014
Perseid Meteor Shower Illinois Science Council in coordination with Chicago Parks Department Chicago, IL	Public Talk 2013
Public Lecture at North Central Purdue University <i>Catching Gravitational Waves with LIGO</i> Westville, IN	Public talk 2011

Teaching/Education Activities

General Relativity <i>Guest Lecturer and TA; Northwestern University, Evanston, IL</i>	Lecture/TA 2015
GK12 Fellowship <i>Reach for the Stars; Highland Park, IL</i> Co-taught weekly in math department of Highland Park High School Developed mathematics lessons, visualizations, and applets for high-school students (Link)	Teaching 2013–2014
Mentoring Telescope Interns Teaching High School Summer Interns at Adler Planetarium; Chicago, IL	Mentoring 2013
Einstein and the 20th Century <i>Guest Lecturer and TA; Northwestern University, Evanston, IL</i>	Lecture/TA 2013
Science Club Mentor Weekly after-school science program at Boys and Girls Club; Chicago, IL	Mentoring 2012–2013

Visualization Creation

Produced for Adler Planetarium Space Visualization Lab and; Chicago, IL
Black Hole Dynamics in Core of Globular Cluster N-Body Simulation ([Link](#))
Binary Black Holes Emitting Gravitational Waves ([Link](#))

Visualizations
2011-2016

Student Mentored and Co-Mentored

Halston Lim

Triple Systems in Galactic Nuclei; MIT

Grad Student
2018-2020

Michael Zevin

Binary-Binary Scatterings in Globular Clusters; KSPI Summer Program

Grad Student
2017-2018

Alexis Ortega

Gravitational-wave Captures in Dense Stellar Environments; Carnegie Mellon

Undergraduate
2020-present

Caitlin Fischer

Spinning Black Hole Triples; MIT Undergraduate Research Opportunities Program

Undergraduate
2017-2018

Joshua Fuhrman

Merging Binary Black Holes in Open Clusters; Northwestern REU

Undergraduate
2016

Hanfei Cui and Peter Phan

Effective Spins of Repeated Black Hole Mergers; Harvard SRMP Program

High School
2019-2020

Service Work

Committee Work at Carnegie Mellon:

- - McWilliams Postdoctoral Fellowship Committee
- Colloquium Committee
- Equity, Diversity, and Inclusion Committee

Committee Service
2019-2020
2020-2021
2020-2021

Peer Reviewer for:

- Physical Review Letters
- Physical Review D
- Astrophysical Journal Letters
- Astrophysical Journal
- Monthly Notices of the Royal Astronomical Society

Referee
2015-Present

Proposal Reviewer for:

- NASA Astrophysical Theory Program
- US-Israel Binational Science Foundation

Referee
2019
2018

IAP Co-Organizer

MIT Independent Activities Period; Cambridge, MA

Organizer
2017

Co-Organizer

Astronomy On Tap – Boston; Cambridge, MA

Organizer
2016-2018