

Kyle Kremer

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Research Summary

My research program builds connections between the fields of stellar dynamics and compact object astrophysics. My areas of expertise include **N-body simulations** of dense star clusters, detection of compact object binaries via **gravitational waves** (e.g., LIGO & LISA), and **high-energy transient phenomena** such as tidal disruption events and fast radio bursts. I have also worked on binary star evolution, hydrodynamics of stellar mergers, millisecond pulsars, intermediate-mass black holes, and X-ray binaries.

Academic Positions

California Institute of Technology	Pasadena, CA
NASA Einstein Fellow	2023–present
NSF Astronomy & Astrophysics Fellow	2020–2022
Carnegie Observatories	Pasadena, CA
NSF Astronomy & Astrophysics Fellow	2020–2022
Northwestern University	Evanston, IL
Postdoctoral Associate	2020
NSF Graduate Research Fellow	2015–2019

Education

Northwestern University	Evanston, IL
<i>Ph.D. in Astronomy</i>	2019
– Thesis: The Role of Black Holes in Globular Cluster Dynamics	
– Advisor: Fred Rasio	
<i>Master of Science in Physics & Astronomy</i>	2017
Colburn Conservatory of Music	Los Angeles, CA
<i>Master of Music</i>	2015
Northwestern University	Evanston, IL
<i>Bachelor of Music; Double Major in Physics and Music Performance</i>	2012

Honors & Awards

NASA Einstein Fellowship	2022
NSF Astronomy & Astrophysics Postdoctoral Fellowship	2020
Carnegie Fellowship in Theoretical Astrophysics (deferred)	2020
Caltech Burke Fellowship (deferred)	2020
NSF Graduate Research Fellowship	2015
Winston Churchill Scholarship	2012
Barry M. Goldwater Scholarship	2011
National Undergraduate Fellowship, Princeton Plasma Physics Laboratory	2011
NASA Summer Research Program, Northwestern University	2009, 2010

Publications

60 total publications, including 18 first-author, 36 co-author, and 6 research notes/proceedings/white papers

First-author publications:

18. **Prospects for detecting fast radio bursts in globular clusters of nearby galaxies**
Kremer, K., Li, D., Lu, W., Piro, A.L., Zhang, B. 2022, submitted to ApJ
17. **Formation of low-mass black holes and single millisecond pulsars in globular clusters**
Kremer, K., Ye, C.S., Kiroğlu, F., Lombardi, J., Ransom, S., Rasio, F.A. 2022, ApJL, 934, L1
16. **Hydrodynamics of close encounters between main-sequence stars and black hole remnants**
Kremer, K., Lombardi, J., Lu, W., Piro, A.L., Rasio, F.A. 2022, ApJ, 933, 203
15. **Dynamical formation channels for fast radio bursts in globular clusters**
Kremer, K., Piro, A.L., Li, D. 2021, ApJL, 917, L11
14. **White dwarf subsystems in core-collapsed globular clusters**
Kremer, K. Rui, N.Z., et al. 2021, ApJ, 917, 28
13. **Fast optical transients from stellar-mass black hole tidal disruption events in young star clusters**
Kremer, K., Lu, W., Piro, A.L., et al. 2021, ApJ, 911, 104
12. **Populating the upper black hole mass gap through stellar collisions in young star clusters**
Kremer, K., Spera, M., Becker, D., Chatterjee, S., et al. 2020, ApJ, 903, 45
11. **Modeling dense star clusters in the Milky Way and beyond with the CMC cluster catalog**
Kremer, K., Ye, C.S., Rui, N.Z., Weatherford, N.C., Chatterjee, S., et al. 2020, ApJS, 247, 48
10. **Probing the survival of planetary systems in globular clusters with tidal disruption events**
Kremer, K., D’Orazio, D.J., Samsing, J., Chatterjee, S., Rasio, F.A. 2019, ApJ, 885, 2
9. **Tidal disruptions of stars by black hole remnants in dense star clusters**
Kremer, K., Lu, W., Rodriguez, C.L., Lachat, M., Rasio, F.A. 2019, ApJ, 881, 75
8. **Post-Newtonian dynamics in dense star clusters: Binary black holes in the LISA band**
Kremer, K., Rodriguez, C. L., Amaro-Seoane, P., Breivik, K., et al. 2019, PRD, 99, 063003
7. **How initial size governs core collapse in globular clusters**
Kremer, K., Chatterjee, S., Ye, C. S., Rodriguez, C. L., Rasio, F. A., 2019, ApJ, 871, 38
6. **Low-mass X-ray binaries ejected from globular clusters**
Kremer, K., Chatterjee, S., Rodriguez, C.L., Rasio, F.A. 2019, submitted to ApJ, arXiv: 1802.04895
5. **How black holes shape globular clusters: Modeling NGC 3201**
Kremer, K., Ye, C. S., Chatterjee, S., Rodriguez, C.L., Rasio, F.A. 2018, ApJL, 855, L15
4. **LISA sources in Milky Way globular clusters**
Kremer, K., Chatterjee, S., Breivik, K., Rodriguez, C.L., Larson, S.L., Rasio, F.A. 2018, PRL, 120, 191103
3. **Accreting black hole binaries in globular clusters**
Kremer, K., Chatterjee, S., Rodriguez, C.L., Rasio, F.A. 2018, ApJ, 852, 29
2. **Accreting double white dwarf binaries: Implications for LISA**
Kremer, K., Breivik, K., Larson, S.L., Kalogera, V. 2017, ApJ, 846, 95
1. **Long-term evolution of double white dwarf binaries accreting through direct impact**
Kremer, K., Sepinsky, J., Kalogera, V. 2015, ApJ, 806, 76

Co-author publications:

36. **Tidal Disruption of Main-Sequence Stars by Intermediate-Mass Black Holes**
Kiroğlu, F. Lombardi, J., Kremer, K., et al. 2022, submitted to ApJ
35. **Intermediate-mass Black Holes on the Run from Young Star Clusters**
González Prieto, E., Kremer, K., et al. 2022, accepted by ApJ
34. **Hyper-Eddington black hole growth in star-forming molecular clouds and galactic nuclei: Can it happen?**
Shi, Y., Kremer, K., Grudić, M.Y., Gerling-Dunsmore, H.J., Hopkins, P.F. 2022, submitted to MNRAS
33. **Radio detection of an elusive hidden millisecond pulsar in the globular cluster NGC 6397**
Zhang, L. et al. (including Kremer, K.) 2022, ApJL, 934, L21
32. **Constraining white dwarf tides from gravitational waves with LISA**
Biscoveanu, S., Kremer, K., Thrane, E. 2022, submitted to ApJL
31. **Astrophysics with the Laser Interferometer Space Antenna**
Amaro-Seoane et al. (including Kremer, K.) 2022, submitted to Living Reviews in Relativity, arXiv:2203.06016
30. **Stellar graveyards: Clustering of compact objects in globular clusters NGC 3201 and NGC 6397**
Vital, E., Kremer, K., Libralato, M., Mamon, G., Bellini, A. 2022, MNRAS, 514, 806

29. **Compact Object Modeling in the Globular Cluster 47 Tucanae**
Ye, C.S., Kremer, K. et al. 2022, ApJ, 931, 84
28. **Gravitational Microlensing Rates in Milky Way Globular Clusters**
Kiroğlu, F., Weatherford, N.C., Kremer, K. et al. 2022, ApJ, 928, 181
27. **The Imprint of Superradiance on Hierarchical Black Hole Mergers**
Payne, E., Sun, L., Kremer, K., Lasky, P.D., Thrane, E. 2022, ApJ, 931, 79
26. **Implications of Eccentric Observations on Binary Black Hole Formation Channels**
Zevin, M., Romero-Shaw, I., Kremer, K., Thrane, E., Lasky, P.D. 2021, ApJ, 921, L43
25. **Modeling Dense Star Clusters in the Milky Way and Beyond with the Cluster Monte Carlo Code**
Rodriguez, C.L. et al. (including Kremer, K.), 2021, ApJS, 258, 22
24. **The Supersonic Project: SIGOs, a Proposed Progenitor to Globular Clusters, and their Connections to Gravitational Wave Anisotropies**
Lake, W., Naoz, S., Chiou, Y.S., Burkhart, B., Marinacci, F., Vogelsberger, M., Kremer, K., 2021, ApJ, 922, 86
23. **Matching globular cluster models to observations**
Rui, N.Z., Kremer, K., Weatherford, N.C., Chatterjee, S., Rasio, F.A., Rodriguez, C.L., Ye, C.S., 2021, ApJ, 912, 102
22. **Intermediate-mass Black Holes from High Massive-star Binary Fractions in Young Star Clusters**
González, E., Kremer, K., Chatterjee, S., Fragione, G., Roderiguez, C.L., et al. 2021, ApJ, 928, L29
21. **Gravitational Waves as a Probe of Globular Cluster Formation and Evolution**
Romero-Shaw, I., Kremer, K., Lasky, P., Thrane, E., Samsing, J. 2021, MNRAS, 506, 2362
20. **Black hole mergers from star clusters with top-heavy initial mass functions**
Weatherford, N.C., Fragione, G., Kremer, K., Ye, C.S., Rasio, F. A., 2021, ApJ, 907, 25L
19. **Joint constraints on the field-cluster mixing fraction, common envelope efficiency, and globular cluster radii from a population of binary hole mergers via deep learning**
Wong, K., Breivik, K., Kremer, K., Callister, T. 2021, PRD, 103, 083021
18. **Neutron Star-Black Hole Mergers from Gravitational Wave Captures**
Hoang, B.-M., Naoz, S., Kremer, K. 2020, ApJ, 903, 8
17. **Black Hole Mergers from Hierarchical Triples in Dense Star Clusters**
Martinez, M. A. S., Fragione, G., Kremer, K., et al. 2020, ApJ, 903, 67
16. **Demographics of triple systems in dense star clusters**
Fragione, G., Martinez, M. A. S., Kremer, K., et al. 2020, ApJ, 900, 16
15. **GW190412 as a third-generation black hole merger from a super star cluster**
Rodriguez, C. L., Kremer, K., Grudić, M., Hafen, Z., et al. 2020, ApJ, 896, L10
14. **Illuminating black hole cusp populations in young star clusters**
Kaaz, N., Kremer, K., Auchettl, K., Ramirez-Ruiz, E. 2020, ApJ, 917, 36
13. **Gravitational-wave captures by intermediate-mass black holes in galactic nuclei**
Fragione, G., Loeb, A. Kremer, K., Rasio, F. A., 2020, ApJ, 897, 46
12. **A dynamical survey of stellar-mass black holes in 50 Milky Way globular clusters**
Weatherford, N.C., Chatterjee, S., Kremer, K., Rasio, F. A., 2020, ApJ, 898, 162
11. **COSMIC variance in binary population synthesis**
Breivik, K., Coughlin, S.C., Zevin, M., Rodriguez, C.L., Kremer, K., et al. 2020, ApJ, 898, 71
10. **On the rate of binary neutron star mergers in globular clusters**
Ye, C.S., Fong, W.-F., Kremer, K., Rodriguez, C.L., Chatterjee, S., Fragione, G., Rasio, F.A., 2020, ApJ, 888, L10
9. **Gravitational-wave captures of single black holes in globular clusters**
Samsing, J., D’Orazio, D.J., Kremer, K., Rodriguez, C.L., Askar, A. 2019, PRD, 101, 123010
8. **Can neutron-star mergers explain the r-process enrichment in globular clusters?**
Zevin, M., Kremer, K., Siegel, D.M., Coughlin, S., Tsang, B.T.-H., Berry, C.P.L., Kalogera, V. 2019, ApJ, 886, 4
7. **Black holes: The next generation – Repeated mergers in dense star clusters and their gravitational-wave properties**
Rodriguez, C.L., Zevin, M., Amaro-Seoane, P., Chatterjee, S., Kremer, K., et al. 2019, PRD, 100, 043027
6. **Probing the black hole merger history in clusters using stellar tidal disruptions**
Samsing, J. et al. (including Kremer, K.) 2019, PRD, 100, 043009
5. **In search of the thermal eccentricity distribution**
Geller, A.M., Leigh, N.W.C., Giersz, M., Kremer, K., Rasio, F.A., 2019, ApJ, 872, 165
4. **Millisecond pulsars and black holes in globular clusters**
Ye, C.S., Kremer, K., Chatterjee, S., Rodriguez, C.L., Rasio, F.A. 2019, ApJ, 877, 122
3. **Post-Newtonian dynamics in dense star clusters: Formation, masses, and merger rates of highly-eccentric black**

hole binaries

Rodriguez, C.L., Amaro-Seoane, P., Chatterjee, S., **Kremer, K.**, et al. 2018, PRD, 98, 123005

2. **Characterizing accreting double white dwarf binaries with LISA and Gaia**

Breivik, K., **Kremer, K.**, Bueno, M., Larson, S.L., Coughlin, S., Kalogera, V. 2018, ApJL, 854, L1

1. **Spin tilts in the double pulsar reveal supernova spin angular-momentum production**

Farr, W.M., **Kremer, K.**, Lyutikov, M., Kalogera, V. 2011, ApJ, 742, 81

Research notes, proceedings, and white papers:

6. **The effect of metallicity on the formation of massive black holes through stellar collisions in young massive star clusters**

Shrivastava, R. & **Kremer, K.** 2022, RNAAS, 6, 157

5. **No black holes in NGC 6397**

Rui, N.Z., Weatherford, N.C., **Kremer, K.**, et al. 2021, RNAAS, 5, 47

4. **The Observed Rate of Binary Black Hole Mergers can be Entirely Explained by Globular Clusters**

Rodriguez, C.L., **Kremer, K.**, et al. 2021, RNAAS, 5, 19

3. **The role of “black hole burning” in the evolution of dense star clusters**

Kremer, K., Ye, C.S., Chatterjee, S., Rodriguez, C.L., Rasio, F.A. 2020, Proceedings of the IAU, 351, 357

2. **Modeling pulsars in dense star clusters**

Ye, C.S., **Kremer, K.**, et al. 2020, Proceedings of the IAU, 351, 357

1. **Gravitational Wave Survey of Galactic Ultra Compact Binaries**

Littenberg, T.B., Breivik, K., Brown, W.R., Eracleous, M., Hermes, J.J., Holley-Bockelmann, K., **Kremer, K.**, et al. 2019, BAAS, 51, 34 (Astro2020: Decadal Survey on Astronomy and Astrophysics)

Observing Programs as PI

A KCWI Black Hole Search in Milky Way Globular Clusters

Keck-II/KCWI, 2022A, 3 half-nights, PI: K. Kremer

Students Mentored

• Donavon Evans (CASSI summer program at Carnegie)	2022 - present
• Riya Shrivastava (CASSI summer program at Carnegie; Caltech SURF program)	2021 - present
• Fulya Kiroğlu (Grad student at NU)	2020 - present
• Elena González (CIERA REU program; now grad student at NU)	2020 - present
• Devin Becker (CIERA REU program; now grad student at MIT)	2019
• Nicholas Rui (CIERA summer student; now grad student at Caltech)	2019
• Mitchell Lachat (CIERA REU program; now grad student at Univ of Rochester)	2018

Invited Presentations

19. AAS HEAD Meeting (special session on intermediate-mass black holes), Waikoloa, Hawaii	March 2023
18. Time Domain and Multimessenger Astrophysics NASA Workshop, Annapolis, MD	August 2022
17. TIFR Astronomy Seminar, Mumbai, IN	May 2022
16. AAS HEAD Meeting (special session on dynamical formation of GW sources), Pittsburgh, PA	March 2022
15. CIERA Science Happy Hour, Northwestern, Evanston, IL	September 2021
14. Niels Bohr Institute, Copenhagen, DK	November 2020
13. Michigan State Astro Seminar, East Lansing, MI	June 2020
12. CGCA Seminar, UW-Milwaukee, Milwaukee, WI	February 2020
11. Harvard-CfA, Cambridge, MA	December 2019
10. Carnegie Observatories Lunch Talk, Pasadena, CA	November 2019
9. Caltech Tea Talk, Pasadena, CA	November 2019
8. UCLA Astro Seminar, Los Angeles, CA	November 2019
7. UC-Santa Barbara Astro Lunch, Santa Barbara, CA	October 2019
6. UC-Santa Cruz FLASH Seminar, Santa Cruz, CA	October 2019
5. MODEST Meeting (Review talk), Bologna, IT	May 2019
4. Caltech TAPIR Seminar, Pasadena, CA	November 2018
3. University of Florida Theoretical Astrophysics Seminar, Gainesville, FL	September 2018

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| 2. Harvard-CfA ITC Seminar, Cambridge, MA | May 2018 |
| 1. MIT Brownbag Seminar, Cambridge, MA | May 2018 |

Contributed Presentations

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| 20. GMT Community Science Meeting (Black Holes at All Scales), Sedona, AZ | September 2022 |
| 19. AAS Summer Meeting, Pasadena, CA | June 2022 |
| 18. IAU 361: Massive Stars Near & Far, Ballyconnell, IR | May 2022 |
| 17. Intermediate-mass Black Holes Meeting, San Juan, PR | April 2022 |
| 16. Dynamical Formation of Gravitational Wave Sources, Aspen, CO | January 2022 |
| 15. FRB 2021 Meeting (virtual) | July 2021 |
| 14. AAS Winter Meeting (dissertation talk), Honolulu, HI | January 2020 |
| 13. The Beginnings and Ends of Double White Dwarfs, Copenhagen, DK | July 2019 |
| 12. MODEST Meeting, Bologna, IT | May 2019 |
| 11. Gravitational-Wave Astrophysics with Populations, Aspen, CO | February 2019 |
| 10. LISA Astrophysics Working Group, Paris, FR | December 2018 |
| 9. Midwest Relativity Meeting, Milwaukee, WI | October 2018 |
| 8. 12th International LISA Symposium, Chicago, IL | July 2018 |
| 7. MODEST Meeting, Santorini, GR | June 2018 |
| 6. American Physical Society April Meeting, Columbus, OH | April 2018 |
| 5. Midwest Relativity Meeting, Ann Arbor, MI | October 2017 |
| 4. MODEST Meeting, Prague, CZ | September 2017 |
| 3. AAS Winter Meeting, Grapevine, TX | January 2017 |
| 2. AAS Summer Meeting, Anchorage, AK | June 2012 |
| 1. APS Division of Plasma Physics Meeting, Salt Lake City, UT | November 2011 |

Teaching Experience

Carnegie Summer Student Program 2021, 2022
 Co-instructor in annual series of lectures for roughly 20 summer undergraduate students. Includes python tutorials, scientific presentation/writing workshops, and research seminars

Guest Lecturer for Caltech graduate students 2021
 Seminar on Stellar Black Holes (taught by S.R. Kulkarni & M. Kasliwal)

Teaching Assistant at Northwestern University 2018
 Introduction to Astrophysics (taught by G. Novak)

Northwestern University Center for Talent 2016
 Developed curriculum and co-taught two-day course on astronomy for class of 20 middle school students

Outreach & Community Engagement

Cosmos in Concert: Founder & Director (www.cosmosinconcert.com) 2015-present
 Educational outreach program combining classical music with astronomy education. Presents multimedia shows featuring live music performance, astronomy visuals, and narration. Presented 17 concerts in six states for audiences totaling over 6,000 people.

- Organized, fundraised, and directed annual concert series at Northwestern University presenting multimedia shows for symphony orchestra. Past concerts include *Solar System Symphony* (Spring 2016), *A Shout Across Time* (Spring 2017), and *Celestial Suite* (Fall 2017).
- Facilitate collaboration with professional orchestras (Boulder Philharmonic Orchestra), top U.S. music conservatories (Bienen School of Music, Colburn School), leading composers (James Stephenson, Matthew Fuerst, Ira Mowitz), and Chicago-area science organizations (Fermi National Lab, Adler Planetarium).
- Featured in local and national news outlets including *Popular Science*, *Splash Magazines*, and *WTTW Chicago Media*.

Science Sonification Project: Co-director 2016-2017

Developed and led a cross-disciplinary collaboration at Northwestern that brought together doctoral students in music composition and the sciences to create original science-inspired music compositions that showcase scientific innovation in the Northwestern research community.

- Facilitated collaboration between six scientists from various departments and six composers from the Bienen School of Music, with each pair creating a unique piece of music.
- As culmination of project, organized the Science Sonification Project Showcase in May 2017, which featured performances of these new compositions. Audience included Northwestern students, faculty, and staff as well as the general public.

The Nettelhorst School: Scientist/Musician-in-Residence 2015-2016

Organized a six-week music/science residency at The Nettelhorst School (a GK-8 Chicago Public School) to develop curriculum that brought music/arts into the science classroom.

- Recruited and led a team of ten Northwestern graduate students from various departments at Northwestern, including the School of Education and Social Policy, Materials Science, and Physics & Astronomy.
- Worked directly with middle school science teachers and students.
- Organized two live music performances presented by musicians from Northwestern's Bienen School of Music.
- In total, the residency reached approximately 500 GK-8 students at Nettelhorst.

Caltech Stargazing Public Lecture Series 2022-present

Served as lecturer and/or panelist for monthly lecture series for general public in Pasadena.

CIERA Astronomer Evenings 2015-2019

Monthly public astronomy lectures at Dearborn Observatory at Northwestern

Professional Service

Conferences Organized:

- CIERA Workshop on Black Hole Dynamics in Clusters December 2018

Peer Reviewer for:

- Nature Astronomy
- Physical Review (PRD and PRL)
- AAS Journals (ApJ and ApJL)
- Monthly Notices of the Royal Astronomical Society
- Classical and Quantum Gravity
- Publications of the Astronomical Society of Australia

Other:

- Caltech Pizza Lunch co-organizer 2022-present
- Caltech TAPIR Seminar co-organizer 2021-present
- CIERA Seminar co-organizer 2019