

H. Thankful Cromartie, PhD | Curriculum Vitæ

Einstein Postdoctoral Fellow

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Research Interests

- Millisecond pulsar (MSP) timing for gravitational wave detection
- MSP mass measurements to constrain the neutron star equation of state
- Radio searches for MSPs & Gamma-ray MSP timing

Education

- 08/14 - 05/20 **The University of Virginia** (*Charlottesville, VA*)
Ph.D. Astronomy (05/2020)
Dissertation title: *Massive, Bright, and Brand-New Millisecond Pulsars as Probes of Fundamental Physics* (DOI: 10.18130/v3-qq0n-2d69)
Advisor: Dr. Scott Ransom, NRAO
M.S. Astronomy (05/2016)
- 08/10 - 05/14 **The University of North Carolina at Chapel Hill** (*Chapel Hill, NC*)
B.S. Physics with Highest Honors (05/2014)
Honors thesis title: *Modeling Gamma-Ray Burst-Associated Type Ic Supernovae: a Genetic Algorithm-Based Approach*
Advisor: Dr. Dan Reichart, UNC
Minor, French (05/2014)

Research Experience

- 09/20 - present **NASA Hubble Fellowship Program Einstein Postdoctoral Fellow**
Cornell University (Ithaca, NY)
I am currently an Einstein Postdoctoral Fellow at Cornell University working within the Center for Astrophysics and Planetary Sciences and the Department of Astronomy. I am also chair of the North American Nanohertz Observatory for Gravitational Waves (NANOGrav) Timing Working Group.
- 05/20 - 09/20 **NANOGrav Postdoctoral Research Associate**
National Radio Astronomy Observatory (Charlottesville, VA)
- 08/14 - 05/20 **Graduate Research & Teaching Assistant**
University of Virginia Department of Astronomy (Charlottesville, VA)
- 05/13 - 08/13 **Research Experience for Undergraduates (REU)**
Arecibo Observatory (Arecibo, Puerto Rico)
- 06/11 - 08/14 **Undergraduate Research Assistant**
UNC-Chapel Hill Gamma-Ray Burst Team (Chapel Hill, NC)

Refereed Publications

Three highlighted publications, then chronological:

- **Cromartie, H. T.**, Fonseca, E., Ransom, S. M., Demorest, et al. [23 additional authors]. *Relativistic Shapiro delay measurements of an extremely massive millisecond pulsar*. *Nature Astronomy*, **4**, 72 (2020).
 - *Our Nature Astronomy publication drew significant press attention (CNN, ABC, Newsweek, Vice, and others). It is in the 99th percentile in online attention among all scientific journal articles of the same age, and was cited more than 80 times in its first month (and now has nearly 700 citations). In addition to giving interviews, I conducted an “Ask Me Anything” Q&A on the AskScience subreddit that attracted ~50k views.*
- **Cromartie, H. T.**, Camilo, F., Kerr, M., Deneva, J. S., et al. [5 additional authors]. *Six New Millisecond Pulsars from Arecibo Searches of Fermi Gamma-Ray Sources*. *ApJ*, **819**, 34 (2016).
 - *Press attention from IFLScience and Phys.org*
- Fonseca, E., **Cromartie, H. T.**, Pennucci, T. et al. *Refined Mass and Geometric Measurements of the High-Mass PSR J0740+6620*. *ApJL*, **915**, L12 (2021).
- Camilo, F., Kerr, M., Ray, P. S., Ransom, S. M., Sarkissian, J., **Cromartie, H. T.**, et al. [10 additional authors]. *Parkes Radio Searches of Fermi Gamma-Ray Sources and Millisecond Pulsar Discoveries*. *ApJ*, **810**, 85 (2015).
- Deneva, J. S., Ray, P. S., Camilo, F., Halpern, J. P., Wood, K., **Cromartie, H. T.**, et al. [6 additional authors]. *Multiwavelength Observations of the Redback Millisecond Pulsar J1048+2339*. *ApJ*, **823**, 105 (2016).
- Arzoumanian, Z. et al. [incl. **H. T. Cromartie**]. *The NANOGrav 11-year Data Set: High-precision Timing of 45 Millisecond Pulsars*. *ApJS*, **235**, 37 (2018).
- Arzoumanian, Z. et al. [incl. **H. T. Cromartie**]. *The NANOGrav 11 Year Data Set: Pulsar-timing Constraints on the Stochastic Gravitational-wave Background*. *ApJ*, **859**, 47 (2018).
- Lam, M. T. et al. [incl. **H. T. Cromartie**]. *A Second Chromatic Timing Event of Interstellar Origin toward PSR J1713+0747*. *ApJ*, **861**, 132 (2018).
- Stovall, K. et al. [incl. **H. T. Cromartie**]. *PSR J2234+0611: A New Laboratory for Stellar Evolution* *ApJ*, **870**, 74 (2019).
- Lam, M. T. et al. [incl. **H. T. Cromartie**]. *The NANOGrav 12.5 yr Data Set: The Frequency Dependence of Pulse Jitter in Precision Millisecond Pulsars*. *ApJ*, **872**, 193 (2019).
- Deneva, J. S., Ray, P. et al. [incl. **H. T. Cromartie**]. *High-Precision X-ray Timing of Three Millisecond Pulsars with NICER: Stability Estimates and Comparison with Radio*. *ApJ*, **874**, 160 (2019).
- Aggarwal, K. et al. [incl. **H. T. Cromartie**]. *The NANOGrav 11-Year Data Set: Limits on Gravitational Waves from Individual Supermassive Black Hole Binaries*. *ApJ*, **880**, 116 (2019).
- Madison, D. R., Agarwal, D., Aggarwal, K., Young, O., **Cromartie, H. T.**, et al. [9 additional authors]. *A Deep Targeted Search for Fast Radio Bursts from the Sites of Low-Redshift Short Gamma-Ray Bursts*. *ApJ*, **887**, 252 (2019).
- Aggarwal, K. et al. [incl. **H. T. Cromartie**]. *The NANOGrav 11 yr Data Set: Limits on Gravitational Wave Memory*. *ApJ*, **889**, 38 (2020).

- Hazboun, J. S. et al. [incl. **H. T. Cromartie**]. *The NANOGrav 11-Year Data Set: Evolution of Gravitational Wave Background Statistics*. ApJ, **890**, 108 (2020).
- Vallisneri, M. et al. [incl. **H. T. Cromartie**]. *Modeling the Uncertainties of Solar System Ephemerides for Robust Gravitational-wave Searches with Pulsar-timing Arrays*. ApJ, **893**, 112 (2020).
- Arzoumanian, Z. et al. [incl. **H. T. Cromartie**]. *Multimessenger Gravitational-wave Searches with Pulsar Timing Arrays: Application to 3C66B Using the NANOGrav 11-year Data Set*. ApJ, **900**, 102 (2020).
- Arzoumanian, Z. et al. [incl. **H. T. Cromartie**]. *The NANOGrav 12.5 yr Data Set: Search for an Isotropic Stochastic Gravitational-wave Background*. ApJL, **905**, L34 (2020).
- Alam, Md F. et al. [incl. **H. T. Cromartie**]. *The NANOGrav 12.5 yr Data Set: Observations and Narrowband Timing of 47 Millisecond Pulsars*. ApJS, **252**, 4 (2021).
- Alam, Md F. et al. [incl. **H. T. Cromartie**]. *The NANOGrav 12.5 yr Data Set: Wideband Timing of 47 Millisecond Pulsars*. ApJS, **252**, 5 (2021).
- Deneva, J. S., Ray, P. S., Camilo, F., Freire, P. C. C., **Cromartie, H. T.**, et al. [incl. 5 additional authors]. *Timing of Eight Binary Millisecond Pulsars Found with Arecibo in Fermi-LAT Unidentified Sources*. ApJ, **909**, 6 (2021).
- Pol, N. S. et al. [incl. **H. T. Cromartie**]. *Astrophysics Milestones For Pulsar Timing Array Gravitational Wave Detection*. ApJL, **911**, L34 (2021).
- Arzoumanian, Z. et al. [incl. **H. T. Cromartie**]. *The NANOGrav 11yr Data Set: Limits on Supermassive Black Hole Binaries in Galaxies within 500Mpc*. ApJ, **914**, 121 (2021).
- Turner, J. E. et al. [incl. **H. T. Cromartie**]. *The NANOGrav 12.5-Year Data Set: Monitoring Interstellar Scattering Delays*. ApJ, **917**, 10 (2021).
- Riley, T. E. et al. [incl. **H. T. Cromartie**]. *A NICER View of the Massive Pulsar PSR J0740+6620 Informed by Radio Timing and XMM-Newton Spectroscopy*. ApJL, **918**, L27 (2021).
- Miller, M. C. et al. [incl. **H. T. Cromartie**]. *The Radius of PSR J0740+6620 from NICER and XMM-Newton Data*. ApJL, **918**, L28 (2021).
- Arzoumanian, Z. et al. [incl. **H. T. Cromartie**]. *Searching For Gravitational Waves From Cosmological Phase Transitions With The NANOGrav 12.5-year dataset*. PRL, accepted (2021).
- Arzoumanian, Z. et al. [incl. **H. T. Cromartie**]. *The NANOGrav 12.5-year data set: Search for Non-Einsteinian Polarization Modes in the Gravitational-Wave Background*. ApJL, accepted (2021).
- Antoniadis, J. et al. [incl. **H. T. Cromartie**]. *The International Pulsar Timing Array second data release: Search for an isotropic Gravitational Wave Background*. MNRAS, accepted (2021).

Publications in Press & Preparation

- **Cromartie, H. T.**, Ransom, S. M., Ray, P. S. et al. *Radio Shapiro delay observations of the NICER MSP J1231–1411*. (Planned ApJ submission for Winter 2021.)
- Kerr, M. et al. [incl. **H. T. Cromartie**]. *Gamma-ray Observations of Millisecond Pulsars Constrain the Low-frequency Gravitational Wave Background*. Science, in review (2021).
- Clark, C. J. et al. [incl. **H. T. Cromartie**]. *Gamma-ray Eclipses in Black-widow and Redback Millisecond Pulsar Binaries*. Nature Astronomy, in review (2021).

- Ray, P. et al. [incl. **H. T. Cromartie**]. *Discovery, Timing, and Multiwavelength Observations of the Black Widow Millisecond Pulsar PSR J1555-2908*. ApJ, in review (2021).
- Nieder, L. et al. [incl. **H. T. Cromartie**]. *Is the black-widow pulsar PSR J1555-2908 in a hierarchical triple system?* (Planned submission for Winter 2021.)

Honors & Awards

- 05/20 **Allan Talbott Gwathmey Memorial Award**
University of Virginia — “An honor reserved for the most accomplished graduate students in the physical sciences at the University of Virginia in recognition of a distinguished scholarly publication”
- 01/20 **AAS Doxsey Travel Prize Honorable Mention**
- 09/19 - 05/20 **Grote Reber Doctoral Fellowship**
National Radio Astronomy Observatory
- 04/19 **American Physical Society Division of Astrophysics Travel Grant**
- 03/19 - present **Member, The Raven Society (University of Virginia)**
“The Raven Society is an honor society committed to recognizing contribution to the University and to fostering academic excellence.”
- 01/19 **Chambliss Astronomy Achievement Award (AAS, Graduate Division)**
- 03/18 **Emma Williams Prize (UVa Astronomy Department)**
Awarded to an outstanding fourth-year graduate student in the department
- 06/16 **IPTA Outstanding Effort Award**
International Pulsar Timing Array — awarded to the collaboration’s diversity committee (see *Selected Service, Teaching, Outreach, & Equity Work*)
- 04/16 **Honorable Mention: Graduate Research Fellowship Program**
National Science Foundation
- 05/14 **Robert Shelton Award for Outstanding Undergraduate Research**
The University of North Carolina Department of Physics & Astronomy
- 05/12 - 05/14 **North Carolina Space Grant (NASA)**
I was awarded two grants to fund my research between 2012 and 2014.
- 11/13 **Bronze-Level Winner, University Physics Competition**
Sponsored by APS and AAS

Invited Talks *NB: Talks between 02/20 and 11/21 were remote unless otherwise noted.*

- 11/21 **DSA-2000 & CHORD Workshop**
NANOGrav & DSA-2000: A Power Couple for Low-Frequency GW Detection
- 06/21 **ECT* Meeting (Neutron stars as laboratories for dense matter)**
Measuring millisecond pulsar masses with radio Shapiro delay observations
I was also invited to be a keynote speaker at the 2022 ECT* conference
- 04/21 **Yale Astronomy Department Colloquium**
A Space-Based Physics Lab: Probing Neutron Star Physics & Gravitational Waves with Millisecond Pulsar Timing
- 02/21 **Cornell Dept. of Astronomy Colloquium**
A Space-Based Physics Lab: Probing Neutron Star Physics & Gravitational Waves with Millisecond Pulsar Timing

- 02/21 **Univ. of Florida Theoretical Astrophysics Seminar**
A Space-Based Physics Lab: Probing Neutron Star Physics & Gravitational Waves with Millisecond Pulsar Timing
- 02/21 **Cornell Friends of Astronomy Seminar**
Millisecond Pulsars: Phenomenal Space-Based Physics Labs
- 10/20 **Cornell Astronomical Society Lecture**
A Space-Based Physics Lab: Probing Neutron Star Physics & Gravitational Waves with Millisecond Pulsar Timing
- 07/20 **Green Bank Observatory**
Recent Relativistic Shapiro Delay Pulsar Observations with the GBT
- 07/20 **AAS High Energy Astrophysics Division**
Radio Shapiro Delay-Enabled Measurements of Two Millisecond Pulsar Masses (invited to speak from pool of applicants)
- 06/20 **Dominion Radio Astrophysical Observatory Seminar**
Shapiro Delay-Enabled Mass Measurements of Two Notable Millisecond Pulsars
- 11/19 **Flatiron Institute Center for Computational Astrophysics (NYC)**
Invited to speak about our recent J0740+6620 results, as well as collaborate with several groups at the institute.
- 11/19 **Meeting of the Southeastern Section of the American Physical Society (Wrightsville Beach, NC)**
Relativistic Shapiro delay measurements of an extremely massive millisecond pulsar
- 11/19 **U. of Maryland Astronomy Dept. Colloquium (College Park, MD)**
High-Mass Neutron Stars for Fun and Profit
- 04/19 **University of Wisconsin Center for Gravitation, Cosmology, and Astrophysics Seminar (Milwaukee, WI)**
A selection of millisecond pulsar science from NANOGrav
- 11/18 **Charlottesville Astronomical Society Lecture (Charlottesville, VA)**
A space-based physics lab: probing neutron star physics with MSP timing
- 09/16 **Virginia Tech Center for Neutrino Physics Colloquium (Blacksburg, VA)**
MSP discoveries with Fermi: implications for gravitational wave detection
- 10/13 **U.S. Naval Research Laboratory Seminar (Washington, D.C.)**
New millisecond pulsars from Arecibo searches of Fermi gamma-ray sources

Other Selected Talks, Workshops & Conferences

- 10/21 **NASA Hubble Fellowship Program Symposium** Talk: *Updates from the North American Nanohertz Observatory for Gravitational Waves*
- 09/20 **NASA Hubble Fellowship Program Symposium** Talk: *Shapiro Delay-Enabled Mass Measurements of Two Notable Millisecond Pulsars*
- 01/20 **American Astronomical Society Winter 2020 Meeting (Honolulu, HI)**
Thesis talk: *Fundamental Physics with Millisecond Pulsars: Gravitational waves, the Neutron Star Equation of State, and Beyond*
- 04/19 **NANOGrav NSF Site Visit (Milwaukee, WI)** Poster: *A very massive neutron star: relativistic Shapiro delay measurements of PSR J0740+6620*
- 04/19 **American Physical Society April Meeting (Denver, CO)** Talk: *A very massive neutron star: relativistic Shapiro delay measurements of PSR J0740+6620*

- 01/19 **American Astronomical Society Winter 2019 Meeting (Seattle, WA)**
 Poster: *Probing the Neutron Star Equation of State via MSP Shapiro Delay*
 Won Chambliss Astronomy Achievement Award
- 01/18 **American Astronomical Society Winter 2018 Meeting & NANOGrav
 Pulsar Timing Array Observatory Planning Meeting (National Harbor,
 MD) Poster: *A Space-Based Physics Lab: the Search for Very High-Mass Neutron
 Stars via Shapiro Delay***
- 10/17 **NANOGrav NSF Site Review Visit (West Virginia University) Poster:**
New MSPs in Fermi γ -Ray Sources: Expediting the Growth of Our PTA
- 09/15 **NANOGrav GW Detection Workshop & Busy Week (Caltech)**
- 2015 - present **NANOGrav Collaboration Meetings**
 Arecibo Observatory, Puerto Rico (02/15)
 Montreal, Canada (10/15)
 Urbana-Champaign, IL (10/16)
 Charlottesville, VA (03/18, talk)
 Green Bank, WV (10/18, talk)
 Ithaca, NY (10/19, talk)
 Remote (10/20 & 05/21)
 Nashville, TN (10/21, talk & discussion moderation)
- 2015 - present **International Pulsar Timing Array Meetings**
 NSW, Australia (07/15)
 Stellenbosch, South Africa (06/16)
 Albuquerque, NM (07/18, oral presentation)
 Pune, India (06/19, talk)
 Remote (09/20)
 Remote (06/21 NANOGrav overview talk)

Observing Campaigns

Green Bank Telescope, P.I. Cromartie:

- 18B-372: *Shapiro Delay Measurements to Refine an MSP's Remarkably High Mass (10 hours)*
- 18B-289: *Mass Measurements for Four MSPs Using Relativistic Shapiro Delay (30 hours)*
- 17B-306: *Measuring the Mass of Two Outstanding MSPs via Shapiro Delay (24 hours)*
- 17A-230: *Black Widow Obs. for NANOGrav Inclusion & Astrophys. Study (46.5 hours)*
- 19A-429: *An Important Mass Measurement of a Nearby Pan-Spectrum MSP (22 hours)*

Arecibo Observatory, P.I. Cromartie:

- P3132: *Observing J1745+1017 for NANOGrav Inclusion and Astrophysical Study (10 hours)*
- P3227: *Timing Six New Fermi MSPs Discovered with the Arecibo Telescope (35.5 hours)*
- P3308: *Probing the Massive Companion of MSP J1304+12 with Shapiro Delay (16.75 hours)*

FAST Telescope, P.I. Cromartie:

- PT2021_0129: *Continued Timing of Six NANOGrav Pulsars (12 hours)*

Notable Co-I observing campaigns:

- NB: Dozens of successful programs (comprising thousands of hours) on which I am a co-author have been omitted from this list, including the NANOGrav observing program at the GBT, VLA, and Arecibo.*
- GBT 22A-399: *Targeted Shapiro-delay Observations of Five NANOGrav Binary Pulsars (35 hours)*
 - GBT 18B-368: *820-MHz observations of PSR J1304+12 (2 hours)*
 - GBT 16B-387/P3138: *A search for radio transients from a recent low-z short GRB (33 hours)*
 - GLST 091250/P3166: *New Searches for Radio MSPs in Fermi Sources (81.5 hours)*
 - GLST131121: *Radio Searches for MSPs Among the 10 Year Fermi LAT Sources (40 hours)*

Selected Service, Teaching, Outreach, & Equity Work

Service Activities:

- 02/21 - present **Chair, NANOGraV Pulsar Timing Working Group**
I was elected to be the chair of NANOGraV's pulsar timing working group, which concerns itself with the NANOGraV observing program and curation of data releases. Responsibilities include leading weekly group meetings and documenting minutes, attending NANOGraV "Council of Chairs" meetings, interfacing with the Management Team, attending NANOGraV advisory board meetings, and more.
- 12/21 **Cornell Astronomy Graduate Student Application Evaluation**
I have volunteered to help with initial reading of graduate student applications.
- 12/20 **Proposal Review Panel**
I served on a Guest Investigator proposal review panel for one of NASA's observatories. Meetings were virtual over a 3-day period. We evaluated 25 proposals.
- 10/20 - present **Cornell Astronomy Journal Club**
I have been co-organizing the weekly Cornell Astronomy journal club. Topics include new arXiv papers, diversity and inclusion-related publications, and research.
- 09/20 & 07/21 **Manuscript Reviews**
I reviewed two articles for *Monthly Notices of the Royal Astronomical Society*.
- 10/16 & 03/19 **Scientific Organizing Committee Service**
I served on the SOC for NANOGraV's Fall 2016 and Spring 2019 meetings.
- 05/16 - 08/19 **Astronomy Representative, UVa Graduate School of Arts and Sciences Council & Huskey Graduate Research Exhibition Organizer**
I represented the Astronomy department from 05/16 to 08/19 (except while on leave). I was the Research Committee Chair for the 2018-2019 school year, planning the school-wide Huskey Graduate Research Exhibition.

Teaching:

- 11/21 **Pulsar Search Collaboratory Guest Lecture**
- 09/21 **Cornell ASTR 1101 Guest Lecture**
- 01/18 - present **Undergraduate & Graduate Mentoring**
I am serving as the primary research advisor for one Cornell undergraduate student and a supplementary mentor for others. I have also served as a resource for summer students and NANOGraV members at the undergraduate and graduate levels.
- Spring 2015 **Lecturer, ASTR 1559: Our Place in Space Lab**
I was wholly responsible for teaching ASTR 1559, an undergraduate course at UVa focusing on remote observing (Professor of record: Dr. Ed Murphy).
- 2015 - 2018 **Grader, Teaching Assistant (UVa)**
I was a teaching assistant for several undergraduate astronomy courses during graduate school. I also graded for the graduate radio astronomy course.
- 06/14 & 06/15 **Coordinator, Educational Research in Radio Astronomy Course (ERIRA)**
I attended the weeklong ERIRA course twice as a coordinator, leading projects and teaching students about concepts in radio astronomy. (*GBO, Green Bank, WV*)
- 02/13 - 03/13 **Sponsor and Mentor, What If? Prize Middle School Competition**
- 08/12 - 12/12 **Grader, Astronomy 101 Lab (UNC-Chapel Hill)**

Public Outreach:

- 03/19 **Charlottesville Astronomy on Tap**
I was a featured speaker during the March 2019 Astronomy on Tap event. Additionally, I volunteered during other AoT events.
- 01/17 - 01/19 **Writer for Astrobites**
Astrobites is a graduate-student-run astronomy blog for which I wrote monthly posts (<https://astrobites.org/author/thankful/>)
- 01/17 **Congressional Outreach for NANOGrav & Arecibo**
I traveled to Washington, D.C. in 2017 to speak to several U.S. Senators, Representatives, and their advisors about the importance of telescope facility funding in the United States. I have also advocated for Arecibo post-collapse by reaching out to my congressional representatives and their aides.
- 2011 - 2014 **Host, Morehead Planetarium Guest Night (Chapel Hill, NC)**
I regularly hosted guest nights, which included answering questions about astronomy and operating the 0.6-m telescope for guests to explore the sky.

Diversity, Equity and Inclusion:

- 06/21 **American Astronomical Society CSWA Blog**
I wrote a blog post for the AAS Committee on the Status of Women in Astronomy as part of their “Women of Arecibo” series.
(<http://womeninastronomy.blogspot.com/2021/06/women-of-arecibo-dr-thankful-cromartie.html>)
- 07/20 - present **Working Group Lead, NHFP Anti-Racism Efforts**
I am a co-founder and participant in a large effort by NASA Hubble Fellowship Program postdocs to combat anti-Black racism in our field, including leading a working group dedicated to securing funds for outreach projects. In addition to working group and all-hands meetings, I have given several presentations at NHFP Symposia and NASA review panels about our work (alongside other fellows).
- 2011 - present **Advocacy Activities Promoting Women in STEM**
My passion for improving the experience of women and other minoritized people in STEM fields started with my co-founding and presidency of the UNC Women in Physics group (2011-2014) as well as my co-presidency of the UNC Society for Physics Students (2013-2014). I helped resurrect and lead the group for graduate and postdoc women in astronomy at UVa and the NRAO. I also penned and read aloud a letter on behalf of (and with assistance from) the astronomy graduate students in response to our concerns about sexual harassment and inclusion in the UVa Astronomy Department. This effort led the faculty and graduate students to participate in relevant training workshops and to the creation of a code of conduct in our department.
- 07/15 - present **Founding & Elected Member, IPTA Diversity Committee**
After the International Pulsar Timing Array (IPTA) Summer 2015 meeting, I asked that the collaboration’s steering committee create a group of delegates from each region’s pulsar timing array to discuss issues relating to diversity and harassment. I was then elected to serve on the committee by NANOGrav. At the 2016 IPTA meeting, we were awarded the IPTA Outstanding Effort Award, in part for our creation of a comprehensive code of conduct.