

Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, CA 91109

Office: 169-236B
E-mail: jordan.mirocha@jpl.nasa.gov
<https://mirochaj.wixsite.com/home>

RESEARCH INTERESTS

Galaxy formation & evolution, stellar feedback, reionization, 21-cm cosmology, first stars & black holes

EDUCATION

University of Colorado, Department of Astrophysical and Planetary Science (APS)	
PhD. Astrophysics	2015
M.S., Astrophysics	2011
Drake University, Department of Physics & Astronomy	
B.S. Physics, B.S. Astronomy	2009

RESEARCH POSITIONS

Senior NASA Postdoctoral Fellow, Jet Propulsion Laboratory	Oct 2022-
Research Associate, McGill University	2020-2022
CITA National Fellow, McGill University	2018-2020
Postdoctoral Scholar, University of California Los Angeles	2015-2018
Graduate Research Assistant, University of Colorado	2009-2015
Undergraduate Research Assistant, Cerro Tololo Inter-American Observatory REU	2009

HONORS & AWARDS

CITA National Fellowship	2018-2020
University of Colorado Graduate School Fellowship	Summer 2015
AAS Rodger Doxsey Travel Prize (Honorable Mention)	225 th AAS Meeting, Jan. 2015
NASA Earth and Space Sciences Fellowship	2014-2015
NSF Graduate Research Fellowship (Honorable Mention)	2011

COLLABORATION INVOLVEMENT

The Spectro-Photometer for the History of the Universe, EoR, and Ices Explorer ([SPHEREx](#))
Science Team Member

Hydrogen Epoch of Reionization Array ([HERA](#))
Cross-Correlations Team Leader
Parameter Estimation and Modeling Team Member

PUBLICATION RECORD (FULL BIBLIOGRAPHY AT THE END)

Refereed Publications (last updated Aug 25, 2023; see also [Google Scholar](#))

Total number of papers: 36

(Co)-Authored by student(s): 10

First author papers: 14

Significant contribution (2nd, 3rd, or corresponding author): 18

Other Publications

Author of [Chapter 2](#) in: “The cosmic 21-cm revolution: charting the first billion years of our Universe”

Author of [white paper](#) submitted to Astro2020 Decadal Survey

TEACHING EXPERIENCE

Classroom:

ASTR 2600: Computational Techniques (CU-Boulder)

Instructor of Record	Summer 2014
Instructor of Record	Spring 2014
Teaching Assistant (with Prof. Jason Glenn)	Fall 2013
Curriculum Development (with Prof. Jason Glenn)	Summer 2013

ASTR 4800: Space Science & Space Policy (CU-Boulder)

Teaching Assistant (with Prof. Jack Burns)	Fall 2011
Teaching Assistant (with Prof. Jack Burns)	Fall 2009

ASTR 001L: Introduction to Astronomy Lab (Drake University)

Teaching Assistant (with Prof. Charles Nelson)	Fall 2006 - Spring 2009
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Guest lectures: PHYS 644 (grad level Galaxies & Cosmology) at McGill (2x; 2019),
ASTR 2600 at CU (5x; 2014-2015), ASTR 4800 at CU (1x; 2009)

Workshops / summer schools:

“Codetober” at McGill, designed scientific computing with PYTHON lesson plan	Oct 2021
CHAMP Camp for HERA summer undergraduate students, intro to PYTHON lecture	June 2021
McGill PhysicsHackathon, designed cryptography challenge problem	Oct 2020
2 nd Mexican AstroCosmoStatistics School (University of Guanajuato), invited lecturer	May 8-12 2017
1 st Mexican AstroCosmoStatistics School (University of Guanajuato), invited lecturer	April 17-21 2016

TRAINING IN TEACHING

Certificate in College Teaching (Graduate Teacher Program at CU-Boulder)

Fall 2015

Requires attendance at 20 teaching workshops, two consultations following video-recording of teaching, and the assembly of a teaching portfolio.

MENTORING EXPERIENCE (†AUTHORED OR CO-AUTHORED PUBLICATION)

Primary Mentor

Sylvia Chow (Cal State Long Beach grad)
Emma Klemets (McGill undergrad → UBC grad)
Felix Bilodeau-Chagnon (McGill undergrad)
†Henri Lamarre (McGill undergrad → UdeM grad)
Kristy Fu (UCLA undergrad → U. Manchester grad)
†Krishma Singal (Georgia Tech undergrad)
†Donald Trinh (UCI undergrad)
Jacob Jost (CU-Boulder undergrad)

Co-Mentor

Thomas McKinley (UCLA postbac → UCSF grad)
Ben Cheung (McGill undergrad)
†Joshua Hibbard (CU-Boulder grad)
Garett Lopez (UCLA undergrad → UCR grad)
†Rick Mebane (UCLA grad → UCSC postdoc)
†Guochao Sun (Caltech grad → Northwestern postdoc)
Scott Sullivan (CU-Boulder grad)

WORKSHOP ORGANIZATION

Reionization and the CMB, local organizing committee	July 2022
The 4 th Global 21-cm Workshop, scientific organizing committee	October 2021
Cross-Correlations with CHORD, co-organizer	October 2021
The 2 nd Global 21-cm Workshop, co-organizer	October 2019

GRANTS & COMPUTING RESOURCES SECURED

Co-I: NSF Astronomy & Astrophysics Grant (PI: La Plante)	2022
Co-I: NASA Astrophysics Theory Grant (PI: Furlanetto)	2022
Co-I: XSEDE <i>Bridges</i> (~ 0.1 – 0.2M SUs / year; Extreme Memory nodes)	2019-

Co-I: Compute Canada <i>Cedar</i> (~ 1.5 M core-hours / year)	2020-
Co-I: NASA <i>Pleiades</i> (~ 0.1 M core-hours)	2016-2019
Co-I: CU-Boulder <i>Janus</i> (~ 0.9 M core-hours)	2014
Co-I: CU-Boulder <i>Janus</i> (~ 0.7 M core-hours)	2012

PROFESSIONAL SERVICE

Referee for:

<i>MNRAS</i>	<i>The Astrophysical Journal Letters</i>	<i>Nature</i>
<i>MNRAS Letters</i>	<i>Physical Review Letters</i>	<i>Nature Astronomy</i>
<i>The Astronomical Journal</i>	<i>Physical Review D</i>	<i>New Astronomy Reviews</i>
<i>The Astrophysical Journal</i>	<i>JCAP</i>	<i>Philosophical Transactions</i>

Proposal Reviewer for: NASA (3x), NSF (1x), ERC (1x), ISF (1x)

DEPARTMENTAL SERVICE & ACTIVITY

Organizer for <i>astro-ph coffee discussions</i> , McGill Space Institute	Summer 2022
<i>CIFAR Gravity & Extreme Universe Annual Meeting</i> , Postdoc Reporter	May 2022
<i>Space Research Conference, McGill Bicentennial</i> , “Future Telescopes” Moderator	May 2022
<i>Seminar Committee</i> , McGill Space Institute	2020-2022
Organizer for “ <i>random papers</i> ” discussion group, McGill Space Institute	2020-2022
Mentor for summer undergrad research program, McGill Space Institute	Summer 2019-2022
Judge for <i>Summer Students’ Final Presentation Symposium</i> , McGill Space Institute	Summer 2021
<i>Undergraduate Research Award Selection Committee</i> , McGill Space Institute	Spring 2021
<i>How to get a postdoc</i> , discussion panel for UCLA graduate students	Spring 2018
<i>Faculty Committee</i> , student representative, CU-Boulder APS Department	2014-2015
<i>Admissions Committee</i> , student representative, CU-Boulder APS Department	Spring 2013
<i>Exams Committee</i> , student representative, CU-Boulder APS Department	Fall 2011
<i>Observatory Committee</i> , student representative, CU-Boulder APS Department	Fall 2009 - Fall 2010

OUTREACH & PRESS

Webinars

<i>Chemistry of the Early Universe</i> , NASA Science Briefing	December 2019
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Articles that reference my work

<i>The James Webb Space Telescope is finding too many early galaxies</i>	January 2023
<i>Bridges Simulations Uncover Shortcoming in Cosmological Models</i>	November 2021

Public Talks

<i>Astronomy on Tap (virtual)</i> , Lansing, MI	July 2021
<i>AstroNight at McGill</i> , Montréal, QC	March 2019
<i>Astronomy on Tap “fly-by”</i> , Vista, CA	April 2017
<i>Astronomy on Tap</i> , Los Angeles, CA	December 2016

Public Observing Nights

CU-Boulder APS Department ($\sim 1 - 2$ nights/semester)	Fall 2009 - Fall 2015
Drake Municipal Observatory ($\sim 1 - 2$ nights/month)	Fall 2006 - Fall 2009

Science Fairs

<i>Explore Your Universe</i> (UCLA), volunteer at “Ask a Scientist!” booth	Fall 2016
<i>Astronomy Day</i> (CU-Boulder), radio/microwave demo operator	Fall 2009 - Fall 2015

Planetarium Shows

Show for 3 rd graders at Lincoln Elementary (west LA) using mobile planetarium	February 2016
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DEPARTMENTAL COLLOQUIA & SEMINARS (*INVITED)

Caltech, Observational Cosmology Seminar	March 2023
*University of Minnesota, Astrophysics Seminar	February 2023
*UC-Berkeley, Cosmology Seminar	January 2023
*Arizona State University, Cosmology Seminar (virtual)	August 2022
*Perimeter Institute Cosmology Seminar (virtual)	March 2022
*West Virginia University, Physics and Astronomy Colloquium (virtual)	January 2022
*Harvard CfA, Galaxies & Cosmology Seminar (virtual)	March 2021
*University of Melbourne, Astronomy Colloquium (virtual)	November 2020
Carnegie Observatories, Lunch Talk (virtual)	November 2020
UC-Davis, Astrophysics Seminar (virtual)	November 2020
*University of Arizona, EURECA Seminar (virtual)	April 2020
University of Zürich, Astrophysics Seminar	September 2019
CITA, Astrophysics Seminar	March 2019
McGill, MSI Seminar	February 2019
UC-Santa Cruz, SCIPP Seminar	November 2018
*Stanford, Cosmology Seminar	November 2018
*UT-Austin, Astronomy Colloquium	September 2018
*UCLA, Astronomy Colloquium	May 2018
Caltech, Tea Talk	November 2017
*UC-Berkeley, Cosmology Seminar	September 2017
UC-Santa Barbara, Astrophysics Lunch Talk	May 2017
Scuola Normale Superiore di Pisa, Astrophysics Seminar	January 2017
Imperial College London, Astrophysics Seminar	January 2017
*Michigan State University, Astrophysics Seminar	November 2016
UCLA, Astrophysics Journal Club	May, 2016
University of Colorado, JILA Astrophysics Seminar	January, 2014
University of Colorado, JILA Astrophysics Seminar	November, 2012

CONFERENCES & WORKSHOPS (*INVITED)

*Reionization in the Summer, Heidelberg, Germany	June 2023
*AAS 241, Special Session: JWST Cosmic Evolution Early Release Science	January 2023
AAS 241, Session on “Intergalactic Medium at Radio and Millimeter Wavelengths”	January 2023
CMB/EoR Workshop at McGill, review on the status of 21-cm observations	July 2022
Canadian Institute for Advanced Research, Gravity & Extreme Universe Annual Meeting	May 2022
Reionization and Cosmic Dawn: Looking Forward to the Past (BCCP)	March 2022
* SAZERAC: The 21-cm signal, review on cross-correlations (virtual)	March 2022
SAZERAC Sip: Models & Simulations of Galaxies (virtual)	October 2021
*CMB S4 Workshop 2021, review on reionization (virtual)	August 2021
The 2 nd Global 21-cm Workshop	October 2020
*The Faint End of the High-z Galaxy UVLF Workshop	December 2018
*Interplay between particle and astro-particle physics, Cincinnati, OH	October 2018
*LHC Results Forum	May 2018
NASA Ames Research Center, Exploration Science Forum	June 2018
*KITP, Dark matter detection and detectability workshop	April 2018
Aspen Center for Physics, Cosmological Signals from Cosmic Dawn to the Present	February 2018
Dawn of Galaxies, Obergurgl, Austria	January 2017
NASA Ames Research Center, Exploration Science Forum	July, 2016
AAS 225, Dissertation Talk	January, 2015
International Union of Radio Science, Boulder	January, 2014
NASA Ames Research Center, NASA Lunar Science Institute Forum	July, 2012

PROFESSIONAL REFERENCES

Prof. Adrian Liu
McGill University
3600 University Street
Montréal, Quebec, Canada H3A 2T8
acliu@physics.mcgill.ca or 514-716-0194

Prof. Steven Furlanetto
University of California Los Angeles
Box 951547, PAB 3-720
Los Angeles, CA 90095-1547
sfurlane@astro.ucla.edu or 310-206-4127

Dr. Tzu-Ching Chang
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, CA 91109
tzu-ching.chang@jpl.nasa.gov or 626-298-5446

Prof. Vera Gluscevic
University of Southern California
825 Bloom Walk, ACB 439
Los Angeles, CA 90089-0484
vera.gluscevic@usc.edu or 213-740-0897 (x0897)

Prof. Jack Burns
Center for Astrophysics and Space Astronomy
University of Colorado Boulder - UCB 391
Boulder, CO 80309-0593
jack.burns@colorado.edu or 303-735-0963

Dr. Jason Glenn
NASA / Goddard Spaceflight Center
Mail Code 665
Greenbelt, MD 20771
jason.glenn@nasa.gov or 301-286-4591

2023

36. “Validating posteriors obtained by an emulator when jointly-fitting the global 21-cm signal and high- z UVLF”
[‡]Dorigo-Jones, J., Rapetti, D., **Mirocha, J.**, [‡]Hibbard, J., Burns, J., and Bassett, N., submitted to *ApJ*
35. “Connecting 21-cm tomography to high-redshift galaxy mapping with machine learning”
[†]Kennedy, J., [†]Carr., J., [‡]Gagnon-Hartman, Liu, A., **Mirocha, J.** et al., submitted to *MNRAS*
34. “Breaking degeneracies in the first galaxies with clustering”
 Muñoz, J.B. **Mirocha, J.**, Furlanetto, S.R., Sabti, N., accepted to *MNRAS Letters*
33. “On the expected purity of photometric galaxy surveys targeting the Cosmic Dawn”
 Furlanetto, S. & **Mirocha, J.**, 2023, *MNRAS*, 523, 5274
32. “Seeking dark matter with γ -ray attenuation”
 Bernal, J.L., Caputo, A., [‡]Sato-Polito, G., **Mirocha, J.**, & Kamionkowski, M., 2023, *PRD*, 107, 103046
31. “Improved Constraints on the 21 cm Power Spectrum with HERA Phase I Observations”
 HERA Collaboration et al. (includes **Mirocha, J.**), 2023, *ApJ*, 945, 124
30. “Prospects for 21-cm – galaxy cross-correlations with HERA and the Roman High-Latitude Survey”
 La Plante, P., **Mirocha, J.**, Gorce, A., Lidz, A., & Parsons, A., *ApJ*, 944, 59L
29. “Balancing the efficiency and stochasticity of star formation with dust in $z > 10$ galaxies observed by JWST”
Mirocha, J., & Furlanetto, S., 2023, *MNRAS*, 519, 843

2022

28. “Structure Formation and the Global 21-cm Signal with Coulomb-like Dark Matter”
[‡]Driskell, G., Nadler, E., **Mirocha, J.**, Benson, A., Boddy, K., Morton, T., [‡]Lashner, J., An, R. & Gluscevic, V., 2022, *Phys. Rev. D*, 106, 103525
27. “Signatures of reionization feedback in the near-infrared background”
Mirocha, J., Liu, A., and La Plante, P., 2022, *MNRAS*, 516, 4123
26. “A galaxy-free phenomenological model for the 21-cm power spectrum during reionization”
Mirocha, J., Muñoz, J.B., Furlanetto, S.R., Liu, A.C., & Mesinger, A., 2022, *MNRAS*, 514, 2010
25. “Constraining Warm Dark Matter and Pop III stars with the Global 21-cm Signal”
[‡]Hibbard, J., **Mirocha, J.**, Rapetti, D., [‡]Basset, N., Tauscher, K., & Burns, J.O., 2022, *ApJ*, 929, 151
24. “Bursty star formation during the Cosmic Dawn driven by delayed stellar feedback”
 Furlanetto, S. & **Mirocha, J.**, 2022, *MNRAS*, 511, 3895
23. “HERA Phase I Limits on the 21-cm Signal: Constraints on Astrophysics and Cosmology During the EoR”
 HERA Collaboration et al. (**Mirocha, J.** led analysis in §6), 2022, *ApJ*, 924, 51

2021

22. “Revealing the formation histories of the first stars with the cosmic near-infrared background”
[‡]Sun, G., **Mirocha, J.**, Mebane, R., and Furlanetto, S.R., 2021, *MNRAS*, 508, 1954
21. “Global 21-cm Absorption Signal from Superconducting Cosmic Strings”
[†]Thériault, R. **Mirocha, J.**, and Brandenberger, R., 2021, *JCAP*, 2021, 046
20. “The importance of galaxy formation histories in models of reionization”
Mirocha, J., La Plante, P., & Liu, A., 2021, *MNRAS*, 507, 3872
19. “Systematic uncertainties in models of cosmic dawn”
Mirocha, J., [†]Lamarre, H., & Liu, A., 2021, *MNRAS*, 504, 1555
18. “A halo model approach for the 21-cm power spectrum during the cosmic dawn”
 Schneider, A., Giri, S., & **Mirocha, J.**, 2021, *Phys. Rev. D*, 103, 3025

2020

17. “Prospects for distinguishing galaxy evolution models with surveys at redshifts $z \gtrsim 4$ ”
Mirocha, J., 2020, *MNRAS*, 499, 4534
16. “Effects of self-consistent rest-ultraviolet colours in semi-empirical galaxy formation models”
Mirocha, J., Mason, C.M., Stark, D.P., 2020, *MNRAS*, 498, 2645
15. “Global 21-cm signal extraction from foreground and instrumental effects. II. Efficient and Self-Consistent...”
 Rapetti, D., [‡]Tauscher, K., **Mirocha, J.**, and Burns, J.O., 2020, *ApJ*, 897, 174

14. [“High-mass X-ray binaries in nearby metal-poor galaxies: on the contribution to nebular HeII emission”](#)
‡Senchyna, P., Stark, D.P., **Mirocha, J.**, Reines, A., Charlot, S., Jones, T., & Mulchaey, J., 2020, *MNRAS* 494, 941
 13. [“The Effects of Population III X-ray and Radio Backgrounds on the Cosmological 21-cm Signal”](#)
‡Mebane, R., **Mirocha, J.**, & Furlanetto, S.R., 2020, *MNRAS*, 493, 1217
- 2016-2019
12. [“What does the first highly-redshifted 21-cm detection tell us about early galaxies?”](#)
Mirocha, J., Furlanetto, S.R., 2019, *MNRAS*, 483, 1980
 11. [“The Persistence of Population III Star Formation”](#)
‡Mebane, R., **Mirocha, J.**, & Furlanetto, S.R., 2018, *MNRAS*, 479, 4544
 10. [“Unique Signatures of Population III in the Global 21-cm Signal”](#)
Mirocha, J., ‡Mebane, R., Furlanetto, S.R., †Singal, K., †Trinh, D., 2018, *MNRAS*, 478, 5604
 9. [“A Minimalist Feedback-Regulated Model for Galaxy Formation During the EoR”](#)
Furlanetto, S.R., **Mirocha, J.**, ‡Mebane, R., †Sun, G., 2017, *MNRAS*, 472, 1576
 8. [“A Space-Based Observational Strategy for Characterizing the First Stars and Galaxies...”](#)
Burns, J.O., Bradley, R., ‡Tauscher, K., Furlanetto, S.R., **Mirocha, J.**, et al., 2017, *ApJ*, 844, 1
 7. [“The Global 21-cm Signal in the Context of the High- \$z\$ Galaxy Luminosity Function”](#)
Mirocha, J., Furlanetto, S.R., †Sun, G., 2017, *MNRAS*, 464, 1365
 6. [“Parametrizations of the 21-cm global signal and parameter estimation from single-dipole experiments”](#)
Harker, G.J.A., **Mirocha, J.**, Burns, J.O., Pritchard, J.R., 2016, *MNRAS*, 455, 3829
- 2012-2015
5. [“Interpreting the Global 21-cm Signal from High Redshifts. II. Parameter Estimation”](#)
Mirocha, J., Harker, G.J.A., Burns, J.O., 2015, *ApJ*, 813, 11
 4. [“Decoding the X-ray Properties of Pre-Reionization Era Sources”](#)
Mirocha, J., 2014, *MNRAS*, 443, 1211
 3. [“Interpreting the Global 21-cm Signal from High Redshifts. I. Model-Independent Constraints”](#)
Mirocha, J., Harker, G.J.A., Burns, J.O., 2013, *ApJ*, 777, 118
 2. [“The Lick-index Calibration of the Gemini Multi-Object Spectrographs”](#)
Puzia, T.H., Miller, B.W., Tranco, G., Basarab, B., **Mirocha, J.**, Butler, K., 2013, *AJ*, 145, 164
 1. [“Optimized Multi-Frequency Spectra for Applications in Radiative Feedback and Reionization”](#)
Mirocha, J., Skory, S., Burns, J.O., Wise, J.W., 2012, *ApJ*, 756, 94

BOOK CONTRIBUTIONS AND REPORTS

2. [“Astrophysics from the 21-cm line”](#)
Mirocha, J., chapter 2 in “The cosmic 21-cm revolution: charting the first billion years of our Universe”
Ed. Andrei Mesinger (Bristol: IOP Publishing Ltd), AAS-IOP ebooks, Dec. 2019
1. [“Farside Array for Radio Science Investigations of the Dark ages and Exoplanets \(FARSIDE\)”](#)
Burns, J.O., Hallinan, G., ..., **Mirocha, J.**, NASA Probe final study report, Nov. 2019

WHITE PAPERS

10. [“Opportunities for galaxy – 21-cm cross-correlations at high redshifts](#)
Mirocha, J., La Plante, P. et al., submitted to the Roman core community surveys call for input
9. [“Canada and the SKA from 2020-2030 ”](#)
Spekkens, K., Chiang, C., ..., **Mirocha, J.**, et al., submitted to the Canadian Long-Range Plan
8. [“A Roadmap for Astrophysics and Cosmology with High-Redshift 21 cm Intensity Mapping”](#)
HERA Collaboration et al. (includes **Mirocha, J.**), submitted as a APC White Paper for Astro2020
7. [“First Stars and Black Holes at Cosmic Dawn with Redshifted 21-cm Observations”](#)
Mirocha, J., Jacobs, D., Dillon, J., et al., submitted to the Astro-2020 Decadal Survey
6. [“Synergies Between Galaxy Surveys and Reionization Measurements”](#)
Furlanetto, S., Beardsley, A., Carilli, C., **Mirocha, J.**, et al., submitted to the Astro-2020 Decadal Survey
5. [“Insights Into the Epoch of Reionization with the Highly-Redshifted 21-cm Line”](#)
Furlanetto, S., Carilli, C., **Mirocha, J.**, et al., submitted to the Astro-2020 Decadal Survey

4. [“Cosmology with the Highly Redshifted 21cm Line ”](#)
Liu, A., Aguirre, J., ..., **Mirocha, J.**, et al., submitted to the Astro-2020 Decadal Survey
3. [“Fundamental Cosmology in the Dark Ages with 21-cm Line Fluctuations”](#)
Furlanetto, S., Bowman, J., **Mirocha, J.**, et al., submitted to the Astro-2020 Decadal Survey
2. [“Cosmic Dawn and Reionization: Astrophysics in the Final Frontier”](#)
Cooray, A., Aguirre, J., ..., **Mirocha, J.**, et al., submitted to the Astro-2020 Decadal Survey
1. [“Mapping Cosmic Dawn and Reionization: Challenges and Synergies”](#)
Alvarez, M., Fialkov, A. La Plante, P., ..., **Mirocha, J.**, et al., submitted to the Astro-2020 Decadal Survey