

Charles J. Law – Curriculum Vitae

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EDUCATION

Ph.D., Astronomy and Astrophysics	2018 – Present
Harvard University, Cambridge, MA	
Thesis: <i>Chemical Complexity at High Spatial Resolution during Star and Planet Formation</i>	
Advisor: Karin I. Öberg	
M.A., Astronomy and Astrophysics	May 2021
Harvard University, Cambridge, MA	
B.A., Physics and Astrophysics	2013 – 2017
Secondary Concentration: Computer Science	
Magna Cum Laude with Highest Honors	
Harvard University, Cambridge, MA	
Thesis: <i>Carbon Chain Molecules Toward Embedded Low-Mass Protostars</i>	
Advisor: Karin I. Öberg	

RESEARCH INTERESTS

I am broadly interested in exploring chemical complexity in space, with a particular focus on (sub)millimeter interferometry. I use high spatial resolution observations to study the chemistry and physics of star and planet formation, including toward low-mass protostars, massive young stellar objects, and protoplanetary disks.

HONORS & AWARDS

Derek Bok Teaching Certificate, Harvard University	2021
Derek Bok Certificate of Excellence and Distinction in Teaching	Spring 2021
NSF Graduate Research Fellowship	2019 – Present
Smithsonian Astrophysical Observatory Research Fellowship	2017
Leo Goldberg Prize in Astronomy, Harvard University	2017
Thomas Temple Hoopes Prize, Harvard University	2017
Phi Beta Kappa, Harvard University	2017
Frederick Tarantino Memorial Scholarship Award, Universities Space Research Assoc.	2016
Harvard College PRISE Research Fellowship	2016
Detur Book Prize, Harvard University	2014
John Harvard Scholar, Harvard University	2014

PUBLICATIONS

Author of 32 publications (refereed or under review), including 8 as first author and 3 as second or third author. A full listing of my publications can be found on [ADS](#).

First Author

- Law, C. J.**, Loomis, R. A., Teague, R., et al., 2021. ApJS, in press, arXiv:2109.06210
[MAPS III. Characteristics of Radial Chemical Substructures](#)
- Law, C. J.**, Teague, R., Loomis, R. A., et al., 2021. ApJS, in press, arXiv:2109.06217

MAPS IV. Emission Surfaces and Vertical Distribution of Molecules

3. **Law, C. J.**, Zhang, Q., Öberg, K. I., et al., 2021. ApJ, 909, 214
Subarcsecond Imaging of the Complex Organic Chemistry in Massive Star-Forming Region G10.6-0.4
4. **Law, C. J.**, Milisavljevic, D., Patnaude, D. J., et al., 2020. ApJ, 894, 73
Three-dimensional Kinematic Reconstruction of the Optically-Emitting, High-Velocity, Oxygen-Rich Ejecta of Supernova Remnant N132D
5. **Law, C. J.**, Zhang, Q., Ricci, L., et al., 2018. ApJ, 865, 17
Submillimeter Array Observations of Extended CO ($J = 2 - 1$) Emission in Interacting Galaxy NGC 3627
6. **Law, C. J.**, Öberg, K. I., Bergner, J. B., et al., 2018. ApJ, 863, 88
Carbon Chain Molecules Toward Embedded Low-Mass Protostars
7. **Law, C. J.**, Ricci, L., Andrews, S. M., et al., 2017. AJ, 154, 255
An SMA Continuum Survey of Circumstellar Disks in the Serpens Star-Forming Region,
8. **Law, C. J.**, Milisavljevic, D., Crabtree, K. N., et al. 2017. MNRAS, 470, 2835
TRES Survey of Variable Diffuse Interstellar Bands

Second or Third Author

1. Teague, R., **Law, C. J.**, Huang, J., et al., 2021. JOSS, under review
disksurf: Extracting the 3D Structure of Protoplanetary Disks
2. Zhang, K., Booth, A., **Law, C. J.**, et al., 2021. ApJS, in press, arXiv:2109.06233
MAPS V. CO Gas Distributions
3. Guzmán, V. V., Bergner, J. B., **Law, C. J.**, et al., 2021. ApJS, in press, arXiv:2109.06391
MAPS VI. Distribution of the Small Organics HCN, C₂H, and H₂CO

Other Co-Authored Publications

1. Anderson, A. R., et al. (incl. **Law, C. J.**), 2021. ApJ, under review
Protostellar and Protoplanetary Disk Masses in the Serpens-Aquila Region
2. Sharda, P, et al. (incl. **Law, C. J.**), 2021. MNRAS, in press, arXiv:2109.03983
First extragalactic measurement of the turbulence driving parameter: ALMA observations of the star-forming region N159E in the Large Magellanic Cloud
3. Martín Doménech, R., et al. (incl. **Law, C. J.**), 2021. ApJ, in press, arXiv:2109.11512
Hot corino chemistry in the Class I binary source Ser-emb 11
4. Öberg, K. I., et al. (incl. **Law, C. J.**), 2021. ApJS, in press, arXiv:2109.06268
MAPS I. Program Overview and Highlights
5. Czekala, I., et al. (incl. **Law, C. J.**), 2021. ApJS, in press, arXiv:2109.06188
MAPS II. CLEAN Strategies for Synthesizing Images of Molecular Line Emission in Protoplanetary Disks
6. Bosman, A. D., et al. (incl. **Law, C. J.**), 2021. ApJS, in press, arXiv:2109.06221
MAPS VII. Substellar O/H and C/H and Superstellar C/O in Planet-feeding Gas
7. Alarcón, F., et al. (incl. **Law, C. J.**), 2021. ApJS, in press, arXiv:2109.06263
Molecules with ALMA at Planet-forming Scales (MAPS) VIII. CO Gap in AS 209 – Gas Depletion or Chemical Processing?
8. Ilee, J. D., et al. (incl. **Law, C. J.**), 2021. ApJS, in press, arXiv:2109.06319
MAPS IX. Distribution and Properties of the Large Organic Molecules HC₃N, CH₃CN, and c-C₃H₂
9. Cataldi, G., et al. (incl. **Law, C. J.**), 2021. ApJS, in press, arXiv:2109.06462
MAPS X. Studying Deuteration at High Angular Resolution toward Protoplanetary Disks
10. Bergner, J. B., et al. (incl. **Law, C. J.**), 2021. ApJS, in press, arXiv:2109.06694
MAPS XI. CN and HCN as Tracers of Photochemistry in Disks
11. Le Gal, R., et al. (incl. **Law, C. J.**), 2021. ApJS, in press, arXiv:2109.06286
MAPS XII. Inferring the C/O and S/H Ratios in Protoplanetary Disks with Sulfur Molecules

12. Aikawa, Y., et al. (incl. **Law, C. J.**), 2021. ApJS, in press, arXiv:2109.06419
[MAPS XIII. HCO⁺ and Disk Ionization Structure](#)
13. Sierra, A., et al. (incl. **Law, C. J.**), 2021. ApJS, in press, arXiv:2109.06433
[MAPS XIV. Revealing Disk Substructures in Multiwavelength Continuum Emission](#)
14. Bosman, A. D., et al. (incl. **Law, C. J.**), 2021. ApJS, in press, arXiv:2109.06223
[MAPS XV. Tracing Protoplanetary Disk Structure within 20 au](#)
15. Booth, A., et al. (incl. **Law, C. J.**), 2021. ApJS, in press, arXiv:2109.06586
[MAPS XVI. Characterizing the Impact of the Molecular Wind on the Evolution of the HD 163296 System](#)
16. Calahan, J., et al. (incl. **Law, C. J.**), 2021. ApJS, in press, arXiv:2109.06202
[MAPS XVII. Determining the 2D Thermal Structure of the HD 163296 Disk](#)
17. Teague, R., et al. (incl. **Law, C. J.**), 2021. ApJS, in press, arXiv:2109.06218
[MAPS XVIII. Kinematic Substructure in the Disks of HD 163296 and MWC 480](#)
18. Huang, J., et al. (incl. **Law, C. J.**), 2021. ApJS, in press, arXiv:2109.06224
[MAPS XIX. Spiral Arms, a Tail, and Diffuse Structures Traced by CO around the GM Aur Disk](#)
19. Schwarz, K., et al. (incl. **Law, C. J.**), 2021. ApJS, in press, arXiv:2109.06228
[MAPS XX. The Massive Disk Around GM Aurigae](#)
20. Sano, H., et al. (incl. **Law, C. J.**), 2020. ApJ, 902, 53
[ALMA CO Observations of Gamma-Ray Supernova Remnant N132D in the Large Magellanic Cloud: Possible Evidence for Shocked Molecular Clouds Illuminated by Cosmic-Ray Protons](#)
21. Le Gal, R., et al. (incl. **Law, C. J.**), 2020. ApJ, 898, 131
[A 3mm chemical exploration of small organics in Class I YSOs](#)

TALKS

I have given a total of 27 talks, including 6 **invited** talks and 6 *public* talks.

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|---|----------------|
| 1. Invited , Leiden Astrochemistry Seminar | October 2021 |
| 2. <i>Public Talk</i> , Beacon Hill Seminar | October 2021 |
| 3. Seminar, Exoplanet Pizza Lunch, CfA | September 2021 |
| 4. Contributed, Chemical processes in Solar-type star forming regions, Turin, Italy | September 2021 |
| 5. Invited , SSP Coffee Talk, CfA | July 2021 |
| 6. Contributed, Emerging Researchers in Exoplanet Science | May 2021 |
| 7. Invited , Origins Seminar, University of Arizona | May 2021 |
| 8. Contributed, Space Telescope, 2021 Spring Symposium | April 2021 |
| 9. Contributed, Five years after HL Tau: a new era in planet formation | December 2020 |
| 10. Contributed, Harvard-Heidelberg Star Formation Workshop | December 2020 |
| 11. Contributed, Astrochemical Frontiers | June 2020 |
| 12. <i>Public Talk</i> , North Shore Amateur Astronomy Club | June 2020 |
| 13. <i>Public Talk</i> , Gloucester Area Astronomy Club | May 2020 |
| 14. <i>Public Talk</i> , Beacon Hill Seminar | March 2020 |
| 15. Seminar, SMA Talk, CfA | February 2020 |
| 16. Contributed, New England Star Formation Meeting, UConn | January 2020 |
| 17. Contributed, 235 th AAS, Honolulu, HI | January 2020 |
| 18. <i>Public Talk</i> , Union County College/AAI, NJ | December 2019 |
| 19. Contributed, Science with the Submillimeter Array: Present and Future | October 2019 |
| 20. Contributed, ISMS, 74 th , Champaign-Urbana, IL | June 2019 |
| 21. Contributed, SNRs II, Chania, Crete, Greece | June 2019 |

22. Seminar, Exoplanet Pizza Lunch, CfA	May 2019
23. Invited , ALMA Community Day, MIT	April 2019
24. Invited , ALMA Community Day, CfA	April 2019
25. Seminar, High Energy Phenomena Seminar, CfA	February 2019
26. Invited , SMA Advisory Committee Meeting, CfA	July 2018
27. <i>Public Talk</i> , Gloucester Area Astronomy Club	September 2018

TELESCOPE OBSERVING & PROPOSALS

PI of 7 programs and Co-I on an additional 31 programs for access to observing facilities such as the SMA, ALMA, VLA, 6.5m Magellan telescope, HST, Chandra, and JWST.

PI

1. Connecting scaling laws between exoplanets and young disks Submillimeter Array , 4 B-ranked Tracks	2020A+2021A
2. Jet-like, IR-bright Ejecta in O-rich LMC Supernova Remnant N132D Magellan Baade 6.5m , FIRE, 3 Nights	2021B
3. Jet-like, IR-bright Ejecta in O-rich LMC Supernova Remnant N132D Magellan Baade 6.5m , FIRE, 4 Nights	2020B
4. Searching for Ionized Accretion Flows around 0.1 pc Scale Clusters with O-Type Stars ALMA , 14.8 hours, C-ranked	Cycle 7
5. Jet-like, Si-rich ejecta in O-rich LMC Supernova Remnant N132D Magellan Baade 6.5m , FIRE, 3 Nights	2019B
6. Formation of O Stars by Accretion of Ionized Gas Very Large Array , 11 hours, A-ranked	2019A
7. Searching for Ionized Accretion Flows around 0.1 pc Scale Clusters with O-Type Stars Submillimeter Array , 8 B-ranked Tracks	2018B+2019A

Co-I

Sub-mm/cm

330.9 hours with **ALMA**
 49.7 hours with **IRAM 30m**
 56 hours with **NOEMA**
 20 tracks with **SMA**
 16.5 hours with **VLA**
 11.75 hours with **GBT**

Optical/IR

20.6 hours with **JWST**
 3 orbits with **HST**
 12 hours with **VLT** (Muse)
 10 nights with **Lick/Shane 3m**
 5 hours with **Gemini**
 1.5 nights with **WIYN**
 0.5 nights with **MMT**

X-ray

50 ks with **Chandra** (HRC)

Observing Experience:

SMA, 15 nights (2016 – 2018)
 FIRE, Magellan Baade 6.5m, 2.5 nights (2019)
 MMT, 1 night [*remote*] (2016)

Funding:

Harvard Data Science Initiative Research Fund, Regularized Maximum Likelihood Imaging: A New Method for Detecting Planets (**\$9,700**; Collaborator, PI: R. Teague)
 NRAO Student Observing Support, VLA 2019A, 2019 (**\$33,601**; Advisor: Q. Zhang)
 ALMA Student Observing Support, ALMA Cycle 4, 2016 (**\$9,000**; Advisor: Q. Zhang)

MAJOR COLLABORATIONS

Molecules with ALMA at Planet-forming Scales (MAPS) 2018 – Present

PI: Karin I. Öberg; co-PIs: Yuri Aikawa, Edwin A. Bergin, Viviana V. Guzmán, Catherine Walsh

ALMA Cycle 6 Large Program to comprehensively survey the chemistry of five protoplanetary disks at high spatial resolution (~15 au)

N132D Chandra Legacy Team 2019 – Present

PI: Paul P. Plucinsky

Chandra Cycle 20 Large Program to obtain legacy observations of N132D at unprecedented depth and integration time (900 ks)

TEACHING

Teaching Fellow, Harvard University

Interstellar Medium and Star Formation (ASTRON 203)

Spring 2021

Stellar and Planetary Astronomy (ASTRON 16)

Spring 2020

Physics I (Lab): Mechanics, Elasticity, Fluids, and Diffusion (PHYS E-1axl)

Fall 2017

Teaching Fellow, Harvard Summer School, Pre-College Program

Introduction to Scientific Programming in Python (CSCI P-14320)

Summer 2019, 2020

Co-Instructor, Harvard Summer School, Pre-College Program

Introduction to Scientific Programming in Python (CSCI P-14320)

Summer 2021

Instructor, Python Workshop, [SAO Latino Initiative Program](#)

Scientific Computing with SciPy

Aug. 16, 2021

OUTREACH

Course Coordinator, Beacon Hill Seminar, [Unveiling the Cosmos](#)

Spring 2021, Fall 2021

Contributing Author, [Astrobites](#)

Jan 2019 – Present

AAS Astronomy Ambassador

Jan 2019 – Present

Volunteer, CfA Public Observatory Night

Fall 2017 – Present

Astronomy Advisor, Harvard Undergraduate Science Olympiad

2018 – 2020

Presenter, Flipped Science Fair, John F. Kennedy School

June 2018, May 2019

Speaker, [Science Research Mentoring Program](#), Cambridge Rindge and Latin School

Mar 2018

Seminar Leader, Harvard Summit for Young Leaders in China

Aug 2017

SERVICE

Referee, A&A, A&A Letters, ApJ, ApJS

2018 – Present

Junior Member, American Astronomical Society

2017 – Present

Subject Matter Expert, NASA JWST Community Events

2021 – Present

Co-Organizer, CfA Star Formation Journal Club Series

Fall 2021 – Present

Member, CfA APS-IDEA, Accessibility & Sustainability Subcommittees

2021 – Present

Peer Mentor, Harvard Astronomy Department

2021 – Present

Co-Organizer, Grad School Visitation Days Spring 2020
Co-Organizer, Student-Faculty Lunch Series Spring 2020
Treasurer & Founding Member, Harvard College Astrophysical Society Nov 2015 – May 2017

MENTORING

Sage Crystian, Harvard Undergraduate Summer 2021 – Present
(co-advised with K. Öberg)

Summer research project mapping vertical gas structures in protoplanetary disks using ALMA data

Prabidhik KC, Harvard Undergraduate Spring 2020 – Present
(co-advised with Q. Zhang)

Independent research project on the chemistry of MYSOs and UC HII regions using SMA data

Devin Sullivan, Harvard Undergraduate Fall 2019
(co-advised with K. Öberg)

[Junior Thesis](#) (AY98) on the distribution of HCN gas in protoplanetary disks using ALMA data