

## Charles J. Law – Curriculum Vitae

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### EDUCATION

<b>Ph.D., Astronomy and Astrophysics</b>	2018 – Present
Harvard University, Cambridge, MA	
Thesis: <i>Chemical Complexity at High Spatial Resolution during Star and Planet Formation</i>	
Advisor: Karin I. Öberg	
<b>M.A., Astronomy and Astrophysics</b>	May 2021
Harvard University, Cambridge, MA	
<b>B.A., Physics and Astrophysics</b>	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

ALMA Ambassador Fellow	2022
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 33 publications (refereed or under review), including 9 as first author and 3 as second or third author. A full listing of my publications can be found on [ADS](#).

#### First Author

1. **Law, C. J.**, Crystian, S., Teague, R., et al., 2022. ApJ, under review  
CO Line Emission Surfaces and Vertical Structure in Mid-Inclination Protoplanetary Disks
2. **Law, C. J.**, Loomis, R. A., Teague, R., et al., 2021. ApJS, 257, 3

[MAPS III. Characteristics of Radial Chemical Substructures](#)

3. **Law, C. J.**, Teague, R., Loomis, R. A., et al., 2021. *ApJS*, 257, 4  
[MAPS IV. Emission Surfaces and Vertical Distribution of Molecules](#)
4. **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](#)
5. **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](#)
6. **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](#)
7. **Law, C. J.**, Öberg, K. I., Bergner, J. B., et al., 2018. *ApJ*, 863, 88  
[Carbon Chain Molecules Toward Embedded Low-Mass Protostars](#)
8. **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,](#)
9. **Law, C. J.**, Milisavljevic, D., Crabtree, K. N., et al. 2017. *MNRAS*, 470, 3  
[TRES Survey of Variable Diffuse Interstellar Bands](#)

## Second or Third Author

1. Teague, R., **Law, C. J.**, Huang, J., et al., 2021. *JOSS*, 6, 67  
[disksurf: Extracting the 3D Structure of Protoplanetary Disks](#)
2. Zhang, K., Booth, A., **Law, C. J.**, et al., 2021. *ApJS*, 257, 5  
[MAPS V. CO Gas Distributions](#)
3. Guzmán, V. V., Bergner, J. B., **Law, C. J.**, et al., 2021. *ApJS*, 257, 6  
[MAPS VI. Distribution of the Small Organics HCN, C<sub>2</sub>H, and H<sub>2</sub>CO](#)

## Other Co-Authored Publications

1. Anderson, A. R., et al. (incl. **Law, C. J.**), 2022. *ApJ*, under review  
Protostellar and Protoplanetary Disk Masses in the Serpens-Aquila Region
2. Sharda, P., et al. (incl. **Law, C. J.**), 2022. *MNRAS*, 509, 2  
[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*, 923, 155  
[Hot corino chemistry in the Class I binary source Ser-emb 11](#)
4. Öberg, K. I., et al. (incl. **Law, C. J.**), 2021. *ApJS*, 257, 1  
[MAPS I. Program Overview and Highlights](#)
5. Czekala, I., et al. (incl. **Law, C. J.**), 2021. *ApJS*, 257, 2  
[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*, 257, 7  
[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*, 257, 8  
[MAPS VIII. CO Gap in AS 209 – Gas Depletion or Chemical Processing?](#)
8. Ilee, J. D., et al. (incl. **Law, C. J.**), 2021. *ApJS*, 257, 9  
[MAPS IX. Distribution and Properties of the Large Organic Molecules HC<sub>3</sub>N, CH<sub>3</sub>CN, and c-C<sub>3</sub>H<sub>2</sub>](#)
9. Cataldi, G., et al. (incl. **Law, C. J.**), 2021. *ApJS*, 257, 10  
[MAPS X. Studying Deuteration at High Angular Resolution toward Protoplanetary Disks](#)
10. Bergner, J. B., et al. (incl. **Law, C. J.**), 2021. *ApJS*, 257, 11  
[MAPS XI. CN and HCN as Tracers of Photochemistry in Disks](#)

11. Le Gal, R., et al. (incl. **Law, C. J.**), 2021. ApJS, 257, 12  
[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, 257, 13  
[MAPS XIII. HCO<sup>+</sup> and Disk Ionization Structure](#)
13. Sierra, A., et al. (incl. **Law, C. J.**), 2021. ApJS, 257, 14  
[MAPS XIV. Revealing Disk Substructures in Multiwavelength Continuum Emission](#)
14. Bosman, A. D., et al. (incl. **Law, C. J.**), 2021. ApJS, 257, 15  
[MAPS XV. Tracing Protoplanetary Disk Structure within 20 au](#)
15. Booth, A., et al. (incl. **Law, C. J.**), 2021. ApJS, 257, 16  
[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, 257, 17  
[MAPS XVII. Determining the 2D Thermal Structure of the HD 163296 Disk](#)
17. Teague, R., et al. (incl. **Law, C. J.**), 2021. ApJS, 257, 18  
[MAPS XVIII. Kinematic Substructure in the Disks of HD 163296 and MWC 480](#)
18. Huang, J., et al. (incl. **Law, C. J.**), 2021. ApJS, 257, 19  
[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, 257, 20  
[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 31 talks, including 8 **invited** and 8 *public* talks.

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|---|------------|
| 1. <i>Public Talk</i> , Cape Cod Astronomical Society                               | Jan. 2022  |
| 2. <b>Invited</b> , Lunch Talk, University of Virginia/NRAO                         | Nov. 2021  |
| 3. <i>Public Talk</i> , Cape Cod Museum of Natural History                          | Nov. 2021  |
| 4. <b>Invited</b> , Astrochemistry Discussion                                       | Nov. 2021  |
| 5. <b>Invited</b> , Leiden Astrochemistry Seminar                                   | Oct. 2021  |
| 6. <i>Public Talk</i> , Beacon Hill Seminar   | Oct. 2021  |
| 7. Seminar, Exoplanet Pizza Lunch, CfA  | Sept. 2021 |
| 8. Contributed, Chemical processes in Solar-type star forming regions, Turin, Italy | Sept. 2021 |
| 9. <b>Invited</b> , SSP Coffee Talk, CfA  | July 2021  |
| 10. Contributed, Emerging Researchers in Exoplanet Science                          | May 2021   |
| 11. <b>Invited</b> , Origins Seminar, University of Arizona                         | May 2021   |
| 12. Contributed, Space Telescope, 2021 Spring Symposium                             | Apr. 2021  |
| 13. Contributed, Five years after HL Tau: a new era in planet formation             | Dec. 2020  |
| 14. Contributed, Harvard-Heidelberg Star Formation Workshop                         | Dec. 2020  |
| 15. Contributed, Astrochemical Frontiers  | June 2020  |
| 16. <i>Public Talk</i> , North Shore Amateur Astronomy Club                         | June 2020  |
| 17. <i>Public Talk</i> , Gloucester Area Astronomy Club                             | May 2020   |
| 18. <i>Public Talk</i> , Beacon Hill Seminar  | Mar. 2020  |
| 19. Seminar, SMA Science Seminar, CfA   | Feb. 2020  |

20. Contributed, New England Star Formation Meeting, UConn	Jan. 2020
21. Contributed, 235 <sup>th</sup> AAS, Honolulu, HI	Jan. 2020
22. <i>Public Talk</i> , Union County College/AAI, NJ	Dec. 2019
23. Contributed, Science with the SMA: Present and Future, Taipei, Taiwan	Oct. 2019
24. Contributed, ISMS, 74 <sup>th</sup> , Champaign-Urbana, IL	June 2019
25. Contributed, SNRs II, Chania, Crete, Greece	June 2019
26. Seminar, Exoplanet Pizza Lunch, CfA	May 2019
27. <b>Invited</b> , ALMA Community Day, MIT	Apr. 2019
28. <b>Invited</b> , ALMA Community Day, CfA	Apr. 2019
29. Seminar, High Energy Phenomena Seminar, CfA	Feb. 2019
30. <b>Invited</b> , SMA Advisory Committee Meeting, CfA	July 2018
31. <i>Public Talk</i> , Gloucester Area Astronomy Club	Sept. 2018

## TELESCOPE OBSERVING & PROPOSALS

PI of 7 programs and Co-I on an additional 34 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 <b>Submillimeter Array</b> , 4 B-ranked Tracks	2020A+2021A
2. Jet-like, IR-bright Ejecta in O-rich LMC Supernova Remnant N132D <b>Magellan Baade 6.5m</b> , FIRE, 3 Nights	2021B
3. Jet-like, IR-bright Ejecta in O-rich LMC Supernova Remnant N132D <b>Magellan Baade 6.5m</b> , FIRE, 4 Nights	2020B
4. Searching for Ionized Accretion Flows around 0.1 pc Scale Clusters with O-Type Stars <b>ALMA</b> , 14.8 hours, C-ranked	Cycle 7
5. Jet-like, Si-rich ejecta in O-rich LMC Supernova Remnant N132D <b>Magellan Baade 6.5m</b> , FIRE, 3 Nights	2019B
6. Formation of O Stars by Accretion of Ionized Gas <b>Very Large Array</b> , 11 hours, A-ranked	2019A
7. Searching for Ionized Accretion Flows around 0.1 pc Scale Clusters with O-Type Stars <b>Submillimeter Array</b> , 8 B-ranked Tracks	2018B+2019A

### Co-I

<i>Sub-mm/cm</i>	<i>Optical/IR</i>	<i>X-ray</i>
330.9 hours with <b>ALMA</b>	20.6 hours with <b>JWST</b>	50 ks with <b>Chandra</b> (HRC)
63.6 hours with <b>ACA</b>	0.5 nights with <b>MMT</b>	
49.7 hours with <b>IRAM 30m</b>	3 orbits with <b>HST</b>	
56 hours with <b>NOEMA</b>	12 hours with <b>VLT</b> (Muse)	
168 hours with <b>SMA</b>	10 nights with <b>Lick/Shane 3m</b>	
16.5 hours with <b>VLA</b>	5 hours with <b>Gemini</b>	
11.75 hours with <b>GBT</b>	1.5 nights with <b>WIYN</b>	

**Observing Experience:**

SMA, 15 nights (2016 – 2018)  
 Magellan Baade 6.5m, 4.5 nights (2019, 2021)  
 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, 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

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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

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**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](#) (ASTRON 98) on the distribution of HCN gas in protoplanetary disks using ALMA data