

# Charles J. Law – Curriculum Vitae

Center for Astrophysics | Harvard & Smithsonian  
60 Garden Street, Cambridge, MA 02138, USA  
[charles.law@cfa.harvard.edu](mailto:charles.law@cfa.harvard.edu) | [claw-astro.github.io](https://github.com/claw-astro)  
ORCID iD: 0000-0003-1413-1776 | 724-493-0763

## EDUCATION

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|-------------------------------------------------------------------------------------------|----------------------------|
| Ph.D., Astronomy and Astrophysics (Harvard University, Cambridge, MA)                     | 2018 – Present             |
| <b>Thesis:</b> Zooming in on the Chemistry of Star and Planet Formation                   | Advisor: Prof. Karin Öberg |
| M.A., Astronomy and Astrophysics (Harvard University, Cambridge, MA)                      | 2021                       |
| B.A., Physics and Astrophysics (Harvard University, Cambridge, MA)                        | 2013 – 2017                |
| <b>Thesis:</b> <a href="#">Carbon Chain Molecules Toward Embedded Low-Mass Protostars</a> | Advisor: Prof. Karin Öberg |

## AWARDS

|                                                                       |      |
|-----------------------------------------------------------------------|------|
| AAS Rodger Doxsey Travel Prize (241 <sup>st</sup> AAS meeting)        | 2023 |
| ALMA Ambassador                                                       | 2022 |
| AAS Chambliss Prize Honorable Mention (235 <sup>th</sup> AAS meeting) | 2020 |
| NSF Graduate Research Fellowship                                      | 2019 |
| 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 |
| USRA Frederick Tarantino Memorial Scholarship Award                   | 2016 |
| PRISE Undergraduate Research Fellowship (Harvard University)          | 2016 |
| Detur Book Prize (Harvard University)                                 | 2014 |
| John Harvard Scholar (Harvard University)                             | 2014 |

## PUBLICATIONS

Author of **40 publications** (refereed or under review), including 10 as first author and 4 as second/third author with major contributions. See a full listing at the end of CV and [ADS](#) library for more details. [649 citations; h-index = 16 (Dec 18, 2022)]

## TALKS

I have given **48 talks**, including 8 invited and 11 public talks. See a full listing at the end of CV.

## TELESCOPE OBSERVING & PROPOSALS

PI of **10 programs** and Co-I on an additional 44 programs for access to observing facilities.

### PI:

|                                                                            |                             |
|----------------------------------------------------------------------------|-----------------------------|
| 1. Linking Ice and Complex Molecule Inventories in MYSOs                   | ALMA, A, 5.4 hrs, Cycle 9   |
| 2. Witnessing Giant Planet Formation in the Act                            | ALMA, B, 6.0 hrs, Cycle 9   |
| 3. Search for a Surviving Stellar Companion of Nearby SNRs E0102 and N132D | Magellan, 2.5 nights, 2022B |
| 4. Connecting Scaling Laws between Exoplanets and Young Disks              | SMA, 8 B-tracks, 2020B/21A  |
| 5. Jet-like, IR-bright Ejecta in O-rich LMC Supernova Remnant N132D        | Magellan, 3 nights, 2021B   |
| 6. Jet-like, IR-bright Ejecta in O-rich LMC Supernova Remnant N132D        | Magellan, 4 nights, 2020B   |
| 7. Ionized Accretion Flows around 0.1 pc Scale Clusters with O-Type Stars  | ALMA, C, 14.8 hrs, Cycle 7  |
| 8. Jet-like, IR-bright Ejecta in O-rich LMC Supernova Remnant N132D        | Magellan, 3 nights, 2019B   |
| 9. Formation of O Stars by Accretion of Ionized Gas                        | VLA, A, 11 hrs, 2019A       |
| 10. Ionized Accretion Flows around 0.1 pc Scale Clusters with O-Type Stars | SMA, 8 B-tracks, 2018B/19A  |

**Co-I:** ALMA (376 hrs), ACA (64 hrs), SMA (256 hrs), VLA (17 hrs), NOEMA (56 hrs), VLBA (72 hrs), GBT (14 hrs), IRAM 30m (50 hrs), JWST (21 hrs), Chandra (190 ks), HST (3 orbits), VLT (12 hrs), Shane (10 nights), Gemini (5 hrs), WIYN (1.5 nights), MMT (0.5 nights)

**Observing:** SMA (15 nights; 2016 – 2018); Magellan (7.5 nights; 2019, 2021, 2022); MMT (1 night; 2016)

**Funding:** ALMA Ambassador (\$10,000), NRAO/SOS, VLA 2019A (\$33,601; Q. Zhang), ALMA/SOS, ALMA Cycle 4 (\$9,000; Q. Zhang)

## MAJOR COLLABORATIONS

|                                                                                                                                                                                                                                                                                                                                                            |                |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| <b>X-ray Mega-Flares in the Orion Nebula Cluster</b><br><i>PI: Konstantin V. Getman</i><br>Multi-telescope (Chandra, VLBA, ALMA, HET) campaign to study flares in ~1000 PMS stars in the ONC                                                                                                                                                               | 2022 – Present |
| <b>N132D Chandra Legacy Team</b><br><i>PI: Paul P. Plucinsky</i><br>Chandra Cycle 20 Large Program legacy observations of SNR N132D at unprecedented depth                                                                                                                                                                                                 | 2019 – Present |
| <b>Molecules with ALMA at Planet-forming Scales (MAPS)</b><br><i>PI: Karin I. Öberg; co-PIs: Yuri Aikawa, Edwin A. Bergin, Viviana V. Guzmán, Catherine Walsh</i><br>ALMA Cycle 6 Large Program to study the chemistry of five protoplanetary disks at 10-20 au scales<br>[MAPS team <a href="#">webpage</a> and selected press <a href="#">coverage</a> ] | 2018 – Present |

## TEACHING

### Teaching Fellow

|                                                                                                   |                   |
|---------------------------------------------------------------------------------------------------|-------------------|
| Interstellar Medium and Star Formation (Graduate, Harvard University)                             | Spring 2021       |
| Stellar and Planetary Astronomy (Undergraduate, Harvard University)                               | Spring 2020       |
| Introduction to Scientific Programming in Python (Harvard Pre-College Program)                    | Summer 2019, 2020 |
| Physics I (Lab): Mechanics, Elasticity, Fluids, and Diffusion (Undergraduate, Harvard University) | Fall 2017         |

### Instructor

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|----------------------------------------------------------------------------------|-------------------|
| Introduction to Scientific Programming in Python (Harvard Pre-College Program)   | Summer 2021, 2022 |
| Scientific Computing with SciPy, Python Workshop (SAO Latino Initiative Program) | Summer 2021, 2022 |
| Unveiling the Cosmos (Beacon Hill Seminars)                                      | Spring, Fall 2021 |

### Pedagogy Training and Teaching Awards

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|--------------------------------------------------------------------------------------|-------------|
| Science Education Undergraduate Mentoring Workshop Series (Harvard University)       | Spring 2022 |
| Derek Bok Teaching Certificate (Harvard University)                                  | 2021        |
| Derek Bok Certificate of Excellence and Distinction in Teaching (Harvard University) | Spring 2021 |

## OUTREACH

|                                                                                                 |                     |
|-------------------------------------------------------------------------------------------------|---------------------|
| Subject Matter Expert, NASA Community College Network                                           | 2022 – Present      |
| Subject Matter Expert, NASA JWST Community Events                                               | 2021 – Present      |
| Volunteer, CfA Public Observatory Night                                                         | 2017 – Present      |
| Guest, Down to Earth with Terry Virts, Podcast                                                  | Feb 2022            |
| Contributing Author, <a href="#">Astrobites</a>                                                 | 2018 – 2020         |
| Astronomy Advisor, Harvard Undergraduate Science Olympiad                                       | 2018 – 2020         |
| Presenter, Flipped Science Fair, John F. Kennedy School                                         | June 2018, May 2019 |
| Speaker, <a href="#">Science Research Mentoring Program</a> , Cambridge Rindge and Latin School | Mar 2018            |

## PROFESSIONAL ACTIVITIES

|                                                          |                |
|----------------------------------------------------------|----------------|
| Referee, A&A, A&A Letters, ApJ, ApJS                     | 2018 – Present |
| Co-Organizer, CfA Star Formation Journal Club            | 2022 – Present |
| Member, CfA APS-IDEA, Accessibility Subcommittee         | 2021 – Present |
| Peer Mentor, Harvard Astronomy Department                | 2021 – Present |
| AAS Astronomy Ambassador                                 | 2019 – Present |
| Organizer, ALMA Data Reduction Workshop, CfA             | Fall 2022      |
| AAS Chambliss Competition Poster Judge                   | Summer 2022    |
| Reviewer, ALMA Archival Student Observing Support awards | Spring 2022    |
| Co-Organizer, Graduate School Visitation Days            | Spring 2020    |
| Co-Organizer, Student-Faculty Lunch Series               | Spring 2020    |

## MENTORING

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I have served as primary science advisor for four students and co-advisor for one student.

|                                                                                      |                           |
|--------------------------------------------------------------------------------------|---------------------------|
| Sarai Rankin (Morgan State, REU Undergraduate)                                       | Summer 2022 – Present     |
| SMA survey of protoplanetary disks in the Cepheus OBb3 star-forming region           |                           |
| Arielle Frommer (Harvard, Undergraduate)                                             | Summer 2022 – Present     |
| Spatially-resolved nitrile chemistry in a sample of massive young stellar objects    |                           |
| Sage Crystian (Harvard, Undergraduate)                                               | Summer 2021               |
| Mapping the vertical structure of protoplanetary disks with CO line emission         |                           |
| Prabidhik KC (Harvard, Undergraduate)                                                | Spring 2020 – Spring 2022 |
| SMA survey of complex chemistry in ultra-compact HII regions                         |                           |
| Devin Sullivan (Harvard, Undergraduate / co-advised with K. Öberg)                   | Fall 2019                 |
| <a href="#">Junior Thesis</a> on the distribution of HCN gas in protoplanetary disks |                           |

## PUBLICATIONS

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A full listing of my publications can be found on [ADS](#).

[649 citations, h-index = 16 (as of Dec 18, 2022); mentees marked with †]

### First Author

1. **Law, C. J.**, Teague, R., Öberg, K. I., et al., 2022. *ApJ*, in press  
Mapping Protoplanetary Disk Vertical Structure with CO Isotopologue Line Emission
2. **Law, C. J.**, Crystian, S.<sup>†</sup>, Teague, R., et al., 2022. [ApJ, 932, 114](#)  
CO Line Emission Surfaces and Vertical Structure in Mid-Inclination Protoplanetary Disks
3. **Law, C. J.**, Loomis, R. A., Teague, R., et al., 2021. [ApJS, 257, 3](#)  
MAPS III. Characteristics of Radial Chemical Substructures
4. **Law, C. J.**, Teague, R., Loomis, R. A., et al., 2021. [ApJS, 257, 4](#)  
MAPS IV. Emission Surfaces and Vertical Distribution of Molecules
5. **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
6. **Law, C. J.**, Milisavljevic, D., Patnaude, D. J., et al., 2020. [ApJ, 894, 73](#)  
3D Kinematic Reconstruction of the Optically-Emitting, High-Velocity, Oxygen-Rich Ejecta of Supernova Remnant N132D
7. **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
8. **Law, C. J.**, Öberg, K. I., Bergner, J. B., et al., 2018. [ApJ, 863, 88](#)  
Carbon Chain Molecules Toward Embedded Low-Mass Protostars
9. **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
10. **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. Muñoz-Romero, C. E., Öberg, K. I., **Law, C. J.**, et al., 2022. *ApJ*, in press [[arXiv:2212.06912](#)]  
Cold Deuterium Fractionation in the Nearest Planet-Forming Disk
2. Teague, R., **Law, C. J.**, Huang, J., et al., 2021. [JOSS, 6, 67](#)  
disksurf: Extracting the 3D Structure of Protoplanetary Disks
3. Zhang, K., Booth, A. S., **Law, C. J.**, et al., 2021. [ApJS, 257, 5](#)  
MAPS V. CO Gas Distributions
4. 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. Pegues, J., et al. (incl. **Law, C. J.**), 2022. *ApJ*, *subm.*  
An SMA Survey of Chemistry in Disks around Herbig AeBe Stars
2. Banovetz, J., et al. (incl. **Law, C. J.**), 2022. *ApJ*, in press  
HST Proper Motion Measurements of Supernova Remnant N132D: Center of Expansion and Age
3. Calahan, J. K., et al. (incl. **Law, C. J.**), 2022. *Nature Astronomy*, in press [[arXiv:2212.05539](#)]  
UV-driven Chemistry as a Signpost of Late-stage Planet Formation
4. Galván-Madrid, R., et al. (incl. **Law, C. J.**), 2022. *ApJL*, in press [[arXiv:2212.05633](#)]  
Clustered Formation of Massive Stars within an Ionized Rotating Disk
5. Anderson, A. R., et al. (incl. **Law, C. J.**), 2022. [ApJ, 938, 55](#)  
Protostellar and Protoplanetary Disk Masses in the Serpens-Aquila Region

6. Bae, J., et al. (incl. **Law, C. J.**), 2022. [ApJL, 934, L20](#)  
MAPS. A Circumplanetary Disk Candidate in Molecular Line Emission in the AS 209 Disk
7. 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
8. 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
9. Öberg, K. I., et al. (incl. **Law, C. J.**), 2021. [ApJS, 257, 1](#)  
MAPS I. Program Overview and Highlights
10. 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
11. 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
12. Alarcón, F., et al. (incl. **Law, C. J.**), 2021. [ApJS, 257, 8](#)  
MAPS VIII. CO Gap in AS 209 – Gas Depletion or Chemical Processing?
13. 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>
14. Cataldi, G., et al. (incl. **Law, C. J.**), 2021. [ApJS, 257, 10](#)  
MAPS X. Studying Deuteration at High Angular Resolution toward Protoplanetary Disks
15. Bergner, J. B., et al. (incl. **Law, C. J.**), 2021. [ApJS, 257, 11](#)  
MAPS XI. CN and HCN as Tracers of Photochemistry in Disks
16. 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
17. Aikawa, Y., et al. (incl. **Law, C. J.**), 2021. [ApJS, 257, 13](#)  
MAPS XIII. HCO<sup>+</sup> and Disk Ionization Structure
18. Sierra, A., et al. (incl. **Law, C. J.**), 2021. [ApJS, 257, 14](#)  
MAPS XIV. Revealing Disk Substructures in Multiwavelength Continuum Emission
19. Bosman, A. D., et al. (incl. **Law, C. J.**), 2021. [ApJS, 257, 15](#)  
MAPS XV. Tracing Protoplanetary Disk Structure within 20 au
20. Booth, A. S., 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
21. Calahan, J. K., et al. (incl. **Law, C. J.**), 2021. [ApJS, 257, 17](#)  
MAPS XVII. Determining the 2D Thermal Structure of the HD 163296 Disk
22. 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
23. 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
24. Schwarz, K. R., et al. (incl. **Law, C. J.**), 2021. [ApJS, 257, 20](#)  
MAPS XX. The Massive Disk Around GM Aurigae
25. 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
26. 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

|                                                                                                            |           |
|------------------------------------------------------------------------------------------------------------|-----------|
| 1. Dissertation Talk, 241 <sup>st</sup> American Astronomical Society (Seattle, WA) <i>[expected]</i>      | Jan 2023  |
| 2. Seminar, Carnegie Earth & Planets Laboratory (virtual)                                                  | Dec 2022  |
| 3. ITC Luncheon Talk, CfA (Cambridge, MA)                                                                  | Oct 2022  |
| 4. Seminar, University of Milan (Milan, Italy)                                                             | Oct 2022  |
| 5. Contributed, From Clouds to Planets II (Berlin, Germany)                                                | Oct 2022  |
| 6. Leiden Astrochemistry Seminar (Leiden, The Netherlands)                                                 | Sept 2022 |
| 7. Planet and Star Formation Coffee, MPIA (Heidelberg, Germany)                                            | Sept 2022 |
| 8. SPF Group Meeting, ESO (Garching, Germany)                                                              | Sept 2022 |
| 9. Contributed, Planet and Binary Formation in GI Discs (Leicester, UK)                                    | Sept 2022 |
| 10. <i>Public Talk</i> , Tellus Science Museum (virtual)                                                   | Aug 2022  |
| 11. Contributed, Northeast Star and Planet Formation Meeting, Wesleyan University (Middletown, CT)         | July 2022 |
| 12. <i>Public Talk</i> , Cape Cod Museum of Natural History (Brewster, MA)                                 | July 2022 |
| 13. <i>Public Talk</i> , Atwood Museum, Cape Cod (Chatham, MA)                                             | July 2022 |
| 14. Contributed, 240 <sup>th</sup> American Astronomical Society (virtual)                                 | June 2022 |
| 15. Contributed, VICO-CICO-CASSUM Spring Workshop, University of Virginia (Charlottesville, VA)            | May 2022  |
| 16. Contributed, Exoplanets IV, AAS Topical Conference Series (Las Vegas, NV)                              | May 2022  |
| 17. Contributed, MAYA: Meeting of ALMA Young Astronomers (virtual)                                         | Mar 2022  |
| 18. Contributed, AstroCheminar, American Chemical Society (virtual)                                        | Jan 2022  |
| 19. <i>Public Talk</i> , Cape Cod Astronomical Society (virtual)                                           | Jan 2022  |
| 20. <b>Invited</b> , Lunch Talk, University of Virginia/NRAO (virtual)                                     | Nov 2021  |
| 21. <i>Public Talk</i> , Cape Cod Museum of Natural History (virtual)                                      | Nov 2021  |
| 22. <b>Invited</b> , Astrochemistry Discussions (virtual)                                                  | Nov 2021  |
| 23. <b>Invited</b> , Leiden Astrochemistry Seminar (virtual)                                               | Oct 2021  |
| 24. <i>Public Talk</i> , Beacon Hill Seminar (virtual)                                                     | Oct 2021  |
| 25. Seminar, Exoplanet Pizza Lunch, CfA (virtual)                                                          | Sept 2021 |
| 26. Contributed, Chemical Processes in Solar-type Star-forming Regions (Turin, Italy)                      | Sept 2021 |
| 27. <b>Invited</b> , SSP Coffee Talk, CfA (virtual)                                                        | July 2021 |
| 28. Contributed, Emerging Researchers in Exoplanet Science (virtual)                                       | May 2021  |
| 29. <b>Invited</b> , Origins Seminar, University of Arizona (virtual)                                      | May 2021  |
| 30. Contributed, Space Telescope, 2021 Spring Symposium (virtual)                                          | Apr 2021  |
| 31. Contributed, Five Years after HL Tau: A New Era in Planet Formation (virtual)                          | Dec 2020  |
| 32. Contributed, Harvard-Heidelberg Star Formation Workshop (virtual)                                      | Dec 2020  |
| 33. Contributed, Astrochemical Frontiers (virtual)                                                         | June 2020 |
| 34. <i>Public Talk</i> , North Shore Amateur Astronomy Club (virtual)                                      | June 2020 |
| 35. <i>Public Talk</i> , Gloucester Area Astronomy Club (virtual)                                          | May 2020  |
| 36. <i>Public Talk</i> , Beacon Hill Seminar (Boston, MA)                                                  | Mar 2020  |
| 37. Seminar, SMA Science Seminar, CfA (Cambridge, MA)                                                      | Feb 2020  |
| 38. Contributed, New England Star Formation Meeting, University of Connecticut (Storrs, CT)                | Jan 2020  |
| 39. Contributed, 235 <sup>th</sup> American Astronomical Society (Honolulu, HI)                            | Jan 2020  |
| 40. <i>Public Talk</i> , Union County College/AAI (Cranford, NJ)                                           | Dec 2019  |
| 41. Contributed, Science with the SMA: Present and Future (Taipei, Taiwan)                                 | Oct 2019  |
| 42. Contributed, 74 <sup>th</sup> International Symposium on Molecular Spectroscopy (Champaign-Urbana, IL) | June 2019 |
| 43. Contributed, Supernova Remnants II: An Odyssey in Space after Stellar Death (Chania, Greece)           | June 2019 |
| 44. Seminar, Exoplanet Pizza Lunch, CfA (Cambridge, MA)                                                    | May 2019  |
| 45. <b>Invited</b> , ALMA Community Day, MIT (Cambridge, MA)                                               | Apr 2019  |
| 46. <b>Invited</b> , ALMA Community Day, CfA (Cambridge, MA)                                               | Apr 2019  |
| 47. Seminar, High Energy Phenomena Seminar, CfA (Cambridge, MA)                                            | Feb 2019  |
| 48. <b>Invited</b> , SMA Advisory Committee Meeting, CfA (Cambridge, MA)                                   | July 2018 |
| 49. <i>Public Talk</i> , Gloucester Area Astronomy Club (Gloucester, MA)                                   | Sept 2018 |