Dr. Edward M. Molter

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Postdoctoral Scholar, Earth and Planetary Science Department, UC Berkeley
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RESEARCH INTERESTS

Planetary atmospheres, planetary rings, radiative transfer, atmospheric dynamics, extreme weather, climate change, photochemistry, interferometry, astronomical software development

EDUCATION

Ph.D. Astrophysics, University of California, Berkeley **August 2022**
Thesis: "Cloud Formation and Circulation in Planetary Tropospheres from Remote-Sensing Data"
Advisers: Dr. William Collins, Dr. Imke de Pater

M.A. Astrophysics, University of California, Berkeley **December 2018**

B.A. Physics, Summa Cum Laude, Macalester College **May 2015**
Thesis: "Constraining the Properties of the Metal-Poor ISM with Interferometric CO Observations of Low Metallicity Dwarf Galaxies"
Adviser: Dr. John Cannon

RESEARCH POSITIONS

CIPS Postdoctoral Scholar, Dept. of Earth & Planetary Science, UC Berkeley **Sep 2022 - present**

Graduate Student Researcher, Lawrence Berkeley National Lab **Aug 2019 - Aug 2022**
Adviser: Dr. William Collins

Graduate Student Researcher, Dept. of Astronomy, UC Berkeley **Jan 2017 - Aug 2019**
Adviser: Dr. Imke de Pater

Visiting Scholar, Keck Observatory **Summer 2017**
Adviser: Dr. Carlos Alvarez

Research Assistant, NASA Goddard Space Flight Center **Aug 2015 - July 2016**
Adviser: Dr. Conor Nixon

Undegraduate Research Assistant, Macalester College **Sep 2014 - May 2015**
Adviser: Dr. John Cannon

NSF REU Research Student, US Geological Survey/Northern Arizona U. **Summer 2014**
Adviser: Dr. Colin Dundas

Visiting Research Student, Université Libre de Bruxelles **Fall 2013**
Adviser: Dr. Nicolas Chamel

Undergraduate Research Assistant, Macalester College **Summer 2013**
Adviser: Dr. John Cannon

REFERREED JOURNAL ARTICLES

First Author: 6, H-index: 11 **Student Advised* https://orcid.org/0000-0003-3799-9033

24. * Helfenbein, M., **Molter, E. M.**, de Pater, I., "Infrared Photometry of Neptune's Small Moons with Keck", in prep.
23. de Pater, I., Lellouch, E., Stroebel, D. F., et al. incl. **Molter, E. M.**, "An Energetic Eruption with associated SO 1.707 micron emissions at Io's Kanehekili Fluctus and a Brightening Event at Loki Patera Observed by JWST", JGR:Planets, 128, e2023JE007872 https://doi.org/10.1029/2023JE007872
22. Akins, A., Hofstadter, M., Butler, B. J., Friedson, A., **Molter, E. M.**, Parisi, M., de Pater, I., "Evidence of a Polar Cyclone on Uranus from VLA Observations", GRL, 50, 10 (2023) http://doi.org/10.1029/2023GL102872

21. **Molter, E. M.**, de Pater, I., Moeckel, C., "Keck Near-Infrared Detections of Mab and Perdita", Icarus Letters, 405, 115697 https://doi.org/10.1016/j.icarus.2023.115697

20. * Chavez, E., de Pater, I., Redwing, E., **Molter, E. M.**, Roman, M. T., Zorzi, A., Alvarez, C., Campbell, R., de Kleer, K., Hueso, R., et al. "Evolution of Neptune at Near-Infrared Wavelengths from 1994 through 2022", Icarus, 404, 115667 http://doi.org/10.1016/j.icarus.2023.115667

19. * Chavez, E., Redwing, E., de Pater, I., Hueso, R., **Molter, E. M.**, Wong, M. H., Alvarez, C., Gates, E., de Kleer, K., et al., "Drift Rates of Major Neptunian Features between 2018 and 2021", Icarus, 410 (2023) https://doi.org/10.1016/j.icarus.2023.115604

18. de Pater, I., **Molter, E. M.**, Moeckel, C. M. "A Review of Radio Observations of the Giant Planets: Probing the Composition, Structure, and Dynamics of Their Deep Atmospheres", Remote Sensing, 15, 5, 1313 (2023) https://doi.org/10.3390/rs15051313

17. Zhang, L., Risser, M., **Molter, E. M.**, Wehner, M. F., O'Brien, T. A., "Accounting for the spatial structure of weather systems in detected changes in precipitation extremes", Weather & Climate Extremes, 100499 (2022) https://doi.org/10.1016/j.wace.2022.100499

16. **Molter, E. M.**, Collins, W. D., Risser, M. D., "Quantitative Precipitation Estimation of Extremes in CONUS with Radar Data", Geophysical Research Letters, 48, 16 (2021) https://doi.org/10.1029/2021GL094697

15. Villanueva, G., Cordiner, M., Irwin, P., et al., incl. **Molter, E.**, "No evidence of phosphine in the atmosphere of Venus from independent analyses", Nature Astronomy 5, 631-635 (2021) https://doi.org/10.1038/s41550-021-01422-z

14. * Zorzi, A., **Molter, E. M.**, de Pater, I., Luszcz-Cook, S. H., Tollefson, J., Wong, M. H., "Evolution of Neptune's Troposphere in 1994-2018 based on HST Observations", Astronomy & Astrophysics, in review

13. Tollefson, J., de Pater, I., **Molter, E. M.**, Sault, R. J., Butler, B. J., Luszcz-Cook, S., DeBoer, D., "Neptune's Spatial Brightness Temperature Variations from the VLA and ALMA", Planetary Science Journal 2, 3 (2021) https://doi.org/10.3847/PSJ/abf837

12. **Molter, E. M.**, de Pater, I., Luszcz-Cook, S., Tollefson, J., Sault, R. J., Butler, B., de Boer, D., "Tropospheric Composition and Circulation of Uranus with ALMA and the VLA", Planetary Science Journal, 2, 1 (2021) https://doi.org/10.3847/PSJ/abc48a

11. Nixon, C. A., Thelen, A. E., Cordiner, M. A., Kisiel, Z., Charnley, S. B., **Molter, E. M.**, Serigano, J., Irwin, P. G. J., Teanby, N., Kuan, Y., "Detection of Cyclopropenylidene on Titan with ALMA", Astronomical Journal, 160, 5 (2020) https://doi.org/10.3847/1538-3881/abb679

10. **Molter, E. M.**, de Pater, I., Roman, M. T., Fletcher, L. N., "Thermal Emission from the Uranian Ring System", Astronomical Journal, 158, 47 (2019) https://doi.org/10.3847/1538-3881/ab258c

9. de Kleer, K., de Pater, I., **Molter, E. M.**, Banks, E., Davies, A. G., Alvarez, C., Campbell, R., et al., "Io's Volcanic Activity from Time Domain Adaptive Optics Observations: 2013-2018", Astronomical Journal, 158, 29 (2019) https://doi.org/10.3847/1538-3881/ab2380

8. **Molter, E. M.**, de Pater, I., Luszcz-Cook, S., Hueso, R., Tollefson, J., Alvarez, C., Sànchez-Lavega, A., Wong, M. H., Hsu, A. I., Sromovsky, L. A., Fry, P. M., Delcroix, M., Campbell, R., de Kleer, K., Gates, E., Lynam, P. D., et al., "Analysis of Neptune's 2017 Bright Equatorial Storm", Icarus, 321, 324 (2019) https://doi.org/10.1016/j.icarus.2018.11.018

7. Thelen, A. E., Nixon, C. A., Chanover, N. J., Cordiner, M. A., **Molter, E. M.**, Teanby, N. A., Irwin, P. G. J., Serigano, J., Charnley, S. B., "Abundance Measurements of Titan's Stratospheric HCN, HC_3N, C_3H_4, and CH_3CN from ALMA observations", Icarus, 319, 417 (2019) https://doi.org/10.1016/j.icarus.2018.09.023

6. Cordiner, M. A., Nixon, C. A., Charnley, S. B., Teanby, N. A., **Molter, E. M.**, Kisiel, Z., Vuitton, V., "Interferometric Imaging of Titan's HC_3N, $H^{13}CCCN$, and $HCCC^{15}N$", Astrophysical Journal Letters, 859, L15 (2018) https://doi.org/10.3847/2041-8213/aac38d

5. Thelen, A. E., Nixon, C. A., Chanover, N. J., **Molter, E. M.**, Cordiner, M. A., Achterberg, R. K., Serigano, J., Irwin, P. G. J., Teanby, N., Charnley, S. B., "Spatial variations in Titan's atmospheric temperature: ALMA and Cassini comparisons from 2012 to 2015", Icarus, 307, 380 (2018) `https://doi.org/10.1016/j.icarus.2017.10.042`

4. Lai, J. C.-Y., Cordiner, M. A., Nixon, C. A., Achterberg, R. K., **Molter, E. M.**, Teanby, N. A., Palmer, M. Y., Charnley, S. B., Lindberg, J. E., Kisiel, Z., Mumma, M. J., Irwin, P. G. J., "Mapping Vinyl Cyanide and Other Nitriles in Titans Atmosphere Using ALMA", Astronomical Journal, 154, 206 (2017) `https://doi.org/10.3847/1538-3881/aa8eef`

3. **Molter, E. M.**, Nixon, C. A., Cordiner, M. A., Serigano, J., Irwin, P. G. J., Teanby, N. A., Charnley, S. B., Lindberg, J. E., "ALMA Observations of HCN and its Isotopologues on Titan", Astronomical Journal, 152, 2 (2016) `https://doi.org/10.3847/0004-6256/152/2/42`

2. Warren, S. R., **Molter, E. M.**, Cannon, J. M., Bolatto, A. D., Adams, E. A. K., Bernstein-Cooper, E. Z., Giovanelli, R., Haynes, M. P., Herrera-Camus, R., Jameson, K., McQuinn, K. B. W., Rhode, K. L., Salzer, J. J., Skillman, E. D., "CARMA CO Observations of Three Extremely Metal-Poor, Star-Forming Galaxies", Astrophysical Journal, 814, 30 (2015) `https://doi.org/10.1088/0004-637X/814/1/30`

1. Chamel, N., **Molter, E.**, Fantina, A. F., Arteaga, D. P., "Maximum strength of the magnetic field in the core of the most massive white dwarfs," Physical Review Letters D, 90, 043002 (2014) `https://doi.org/10.1103/PhysRevD.90.043002`

TELESCOPE TIME AWARDED

Atacama Large (sub-)Millimeter Array (ALMA)

2. Primary Investigator, *Thermal Properties of the Uranian Rings*, 8.5 hours

1. Primary Investigator, *Opacity Variability in Uranus's Troposphere*, 3.7 hours
Funding awarded ($17,500) via NRAO Student Observing Support Award

James Webb Space Telescope (JWST)

1. co-Investigator, *ERS observations of the Jovian System as a demonstration of JWST's capabilities for Solar System science*, Instruments: Multiple; PIs: T. Fouchet and I. de Pater, 28.9 hours

W. M. Keck Observatory

3. co-Investigator, *The Twilight Zone: Cadenced Twilight Observations of Solar System Bodies*, long-term program. Instruments: NIRC2, Osiris; PIs: I. de Pater, K. de Kleer, A. Davies, 2018-present. >100 activations, 0.5 hours each

2. co-Investigator, *Spatial Distribution of H_2S on Neptune and Uranus*, Instrument: OSIRIS; PI: I. de Pater, 1.0 nights

1. co-Investigator, *Uranus from Equinox to Mid-Spring: Tropospheric Temperatures, Seasonal Changes, and Emerging Rings*, Instrument: Subaru COMICS; PI: J. Sinclair, 1.0 nights

Very Large Array (VLA)

1. co-Investigator, *Seasonal Variations in the Microwave Emission of Uranus*, PI: Alex Akins, 18.0 hours

Very Large Telescope (VLT)

2. co-Investigator, *Uranus from Equinox to Mid-Spring: Temperature Structure, Photochemistry, Seasonal Changes, and Emerging Rings*, Instrument: VISIR; PI: M. Roman, 14.5 hours

1. co-Investigator, *Resolve Loki Patera on Jupiters Satellite Io with Matisse*, Instrument: MATISSE; PI: I. de Pater, 3 hours

Paranal Observatory

1. co-Investigator, *Preparatory observations for GTO program on Matisse of Io's Loki Patera*, Instrument: NACO; PI: I. de Pater, XX activations, 0.5 hours each

Lick Observatory

1. Primary & co-Investigator, *Origin & Evolution of Storms, Clouds, and Hazes on Uranus and Neptune*, long-term program. Instrument: ShARCS; PIs: E. Molter, J. Tollefson, E. Redwing. >100 activations, 1 hour each

OPEN-SOURCE SOFTWARE

I actively contribute to the open-source software ecosystem within planetary science:

- Contributed the Planetary Ring Node query tool to astropy's astroquery package (BeautifulSoup, astropy, pytest; Merged PR here)
- Developed the Keck Observatory Twilight Zone observing tools and public-facing website (html, bash, csh, matplotlib, numpy)
- Maintain the pylanetary open-source package for comparing models of solar system planets with data (astropy, scipy, scikit-image, numpy, matplotlib, sphinx, pytest, GitHub CI)
- Maintain the nirc2_reduce open-source package for processing infrared imaging data (astropy, scipy, scikit-image, numpy, matplotlib, sphinx, pytest, GitHub CI)
- Contributed MCMC support and realistic cloud physics to the radiobear radiative transfer code (numpy, scipy, emcee, matplotlib; published in Tollefson+21, Molter+21, de Pater+23)
- Co-maintain the `sunbear` radiative transfer code. First public release coming soon! (cython, numpy, pytest; published in Luszcz-Cook+16, Molter+19, Chavez+23)
- Published a paper with the showyourwork workflow for open and reproducible science publications (Snakemake, LaTeX, GitHub CI; GitHub repo here)

TEACHING, OUTREACH, & MENTORSHIP

Mentor, Berkeley Undergraduate Research Apprentice Program	Spring 2022 - Present
Volunteer Organizer, Berkeley Climate & Impacts Research Hub	Fall 2020 - Spring 2022
Graduate Student Instructor, UC Berkeley	
C162 Planetary Astrophysics	Fall 2018
C12 The Planets	Spring 2017
C10 Introduction to General Astronomy	Fall 2016
Volunteer Panelist, Branson School Science Symposium	2018, 2019
Volunteer Instructor, Splash @ Berkeley	2018
Peer Mentor, Berkeley Astronomy Dept.	Fall 2018 - Present
Orientation Leader, Macalester College Dept of Student Affairs	Fall 2012
Program Staff (full-time), Camp Becket/Chimney Corners YMCA, Becket, MA	Summer 2012

PROFESSIONAL DEVELOMENT

.Astronomy 12, Flatiron Institute, NY	October 2023 (accepted)
Astronomical Software Development Workshop, Flatiron Institute, NY	May 2022
Graduate Climate Conference (GCC), Virtual	October 2021
Unlearning Racism in the Geosciences (URGE) Berkeley Chapter, Virtual	Fall 2020
JPL Center for Climate Sciences Summer School, Virtual	August 2020
Physics in Machine Learning Workshop, Berkeley, California	May 2019
Very Large Array (VLA) Synthesis Imaging Workshop, Socorro, New Mexico	May 2018
Very Large Array (VLA) Data Reduction Workshop, Socorro, New Mexico	October 2017
JWST Early Release Science Proposal Writing Workshop, Leiden, Netherlands	May 2017
Titan Aeronomy and Climate Workshop, Reims, France	June 2016
Combined Array for Research in Millimeter Astronomy (CARMA) Summer School, Big Pine, CA	August 2014
Undergraduate ALFALFA Team Workshop, Arecibo, Puerto Rico	January 2014

PROFESSIONAL SERVICE

Member, ngVLA (next-generation Very Large Array) Transition Advisory Group	May 2022 - present
Panelist, NASA Cassini Data Analysis Program funding proposal review panel	August 2023
Referee, MDPI Universe	ongoing
Organizer, Center for Integrative Planetary Sciences Seminar	Fall 2022 - present
Organizer, Berkeley Climate & Impacts Research Hub	Fall 2020 - Spring 2022
Facilitator, open-source software discussion at Uranus Flagship workshop (Caltech)	July 2023

CONFERENCE PRESENTATIONS

16. "The Uranian Circumplanetary System: Synergy between Ground-Based Radio Observations and UOP", Uranus Flagship Mission workshop (2023) `[click for 2-page abstract]`
15. "The Atmosphere and Rings of Uranus at 25 mas Resolution with ALMA", AGU Fall Meeting, P23B-07 (2022)
14. "A Storm-Resolving Data Set for Analysis of Precipitation at its Native Scale, Diagnosis of Cloud-Resolving Models, and Development of Next-Generation Parameterizations", AGU Fall Meeting, A45Q-2082 (2021)
13. "Quantitative Precipitation Estimation of Extremes over the Continental United States with Radar Data", AMS Annual Meeting, 2A.1 (2021) [`click for video recording`]
12. **(Invited)** "Thermal Measurements of the Ring System of Uranus", AGU Fall Meeting, P017-03 (2020)
11. "Quantitative Precipitation Estimation of Extremes over the Continental United States with Radar Data", AGU Fall Meeting, A042-0014 (2020)
10. "Uranus's Tropospheric Circulation and Composition with ALMA and the VLA", EPSC/DPS Meeting 13, 726-1 (2019)
9. "Uranian Atmosphere and Rings Probed with ALMA Observations", AAS/DPS Meeting, 50, 104.07 (2018)
8. "Mapping circulation and chemistry in Uranus's deep atmosphere with radio observations", Astrophysical Frontiers in the Next Decade and Beyond Meeting (2018)
7. "Discovery of a Bright Equatorial Storm on Neptune", AGU Fall Meeting, P31D-2856 (2017)
6. "Isotopic Ratios in Nitrile Species on Titan using ALMA", Titan Aeronomy & Climate Workshop, #37 (2016)
5. "Observations of HCN and its Isotopologues on Titan using ALMA", AAS, 227, #141.19 (2016)
4. "Vertical Profiles and Isotopic Ratios in HCN and its Isotopologues from ALMA Observations of Titan", AAS/DPS, 47, #310.15 (2015)
3. "Testing for the Influence of Insolation on Formation and Growth of Hollows on Mercury," LPSC, 46, #1489 (2015)
2. "CO Observations of DDO 68: An Extreme Outlier on the Mass-Metallicity Relation", AAS, 225, #248.18 (2015)
1. "The Low CO Luminosity of Three Extremely Metal-Poor Star-Forming Galaxies", AAS, 223, #246.52 (2014)

PUBLICITY

Press Release, UC Berkeley / NASA, "Surprising details leap out in sharp new James Webb Space Telescope images of Jupiter"	August 2023
Press Release, UC Berkeley, "Berkeley Astronomers to Put New Space Telescope Through its Paces"	January 2022
Interview, Futurism, "Here's What Uranus Scientists Think About Your Disgusting Jokes"	November 2021
Press Release, NASA, "NASA Scientists Discover 'Weird' Molecule in Titan's Atmosphere"	October 2020
Press Release, UC Berkeley, "Astronomers see 'warm' glow of Uranus's rings"	June 2019
Nature Research Highlight, "Epic storm roils a tranquil region of Neptune"	December 2018
Press Release, UC Berkeley/Keck Observatory, "New Storm Makes Surprise Appearance on Neptune"	August 2018

SELECTED GRADUATE COURSEWORK

I took advantage of the rich academic program at UC Berkeley by enrolling in classes throughout my graduate career, going well beyond the coursework requirements:

11.	Effective Mentoring in Higher Education	Spring 2022
10.	Python Computing for Data Science	Spring 2022
9.	Unlearning Racism in the Geosciences (URGE)	Spring 2021
8.	Global Circulation of Planetary Atmospheres	Fall 2020
7.	Computational Fluid Dynamics	Fall 2020
6.	Atmospheric Physics and Dynamics (audit)	Fall 2019
5.	Astrophysical Fluid Dynamics	Spring 2018
4.	Radiation and its Interactions with Climate	Fall 2017
3.	Solar System Astrophysics	Fall 2017
2.	Astrophysical Techniques	Spring 2017
1.	Radiative Processes in Astronomy	Fall 2016