Curriculum Vitae

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Sagnick Mukherjee

Designation: 5th Year PhD Candidate,
PhD Program in Astronomy and Astrophysics,
Department of Astronomy and Astrophysics,
University of California, Santa Cruz
Expected Graduation: Spring, 2025
Email: samukher@ucsc.edu
Website: https://sagnickm.github.io/
ORCID: 0000-0003-1622-1302
UAT keywords: Exoplanet atmospheric dynamics(2307), Exoplanet atmospheres(487), Brown dwarfs(185)

Academic Qualification

Examination / Degree	Board / Institute	Subjects	Year	Percentage/ Grade Points
Ph.D	UC Santa Cruz	Astronomy and Astrophysics	2020-25 (expected)	Ongoing
Master of Science	UC Santa Cruz	Astronomy and Astrophysics	2020-22	4/4
Master of Science	Presidency University	Physics Major	2018-20	9.65/10 (Gold Medal)
Bachelor of Science	Presidency University	Physics Major	2015-18	9.21/10 (Gold Medal)

Research Work

I am primarily interested in building models of exoplanet and brown dwarf atmospheres and using them with observational data to probe the physical/chemical processes ongoing in these atmospheres. I have used my models with James Webb Space Telescope (JWST) and ground-based telescope observations of these objects. I aim to probe the nature of multiple physical processes like vertical mixing, photochemistry, and cloud formation in the atmospheres of these objects. I am also interested in understanding the interior structure and evolution of exoplanets and brown dwarfs over time. I am the Principal Investigator and Co-Investigator of several approved observational and theoretical JWST programs focused on understanding the atmospheres and interiors of exoplanets and brown dwarfs.

First Authored Publications

1. "Effects of Planetary Parameters on Disequilibrium Chemistry in Irradiated Planetary Atmospheres: From Gas Giants to Sub-Neptunes", **Sagnick Mukherjee**, Jonathan J. Fortney, Nicholas F. Wogan, David K. Sing, Kazumasa Ohno, (2024, ApJ, Under Review)

2. "Uncovering the Atmosphere of GJ 436b with *JWST* Observations", **Sagnick Mukherjee**, Jonathan J. Fortney, Everett Schlawin, Taylor J. Bell, et al.,(in preparation for ApJL, 2024)

3. "The Sonora Substellar Atmosphere Models. IV. Elf Owl: Atmospheric Mixing and Chemical Disequilibrium With Varying Metallicity and C/O Ratios", **Sagnick Mukherjee**, Jonathan J. Fortney, Caroline V. Morley, Natasha E. Batalha, Mark S. Marley, Theodora Karalidi, Channon Visscher, Roxana Lupu, Richard Freedman, Ehsan Gharib-Nezhad, (2023, The Astrophysical Journal)

4. "Probing the Extent of Vertical Mixing in Brown Dwarf Atmospheres with Disequilibrium Chemistry", **Sagnick Mukherjee**, Jonathan J. Fortney, Natasha E. Batalha, Theodora Karilidi, Mark S. Marley, Channon Visscher, Brittany E. Miles, Andrew J. I. Skemer (**2022**, The Astrophysical Journal (ApJ), Volume 938, 107)

5. "PICASO 3.0: A One-Dimensional Climate Model for Giant Planets and Brown Dwarfs", **Sagnick Mukherjee**, Natasha E. Batalha, Jonathan J. Fortney, Mark S Marley (**2022**, The Astrophysical Journal (ApJ, Volume 942, Number 2))

6. "Modeling Polarization Signals from Cloudy Brown Dwarfs Luhman 16 A and B in Three Dimensions", **Sagnick Mukherjee**, Jonathan J. Fortney, Rebecca Jensen-Clem, Xianyu Tan, Mark S. Marley, and Natasha E. Batalha (**2021**, The Astrophysical Journal, Volume 923, Number 1)

7. "Cloud Parameterizations and their Effect on Retrievals of Exoplanet Reflection Spectroscopy", **Sagnick Mukherjee**, Natasha E. Batalha, and Mark S. Marley (**2021**,The Astrophysical Journal, Volume 910, Number 2)

8. "The accretion disc-jet connection in blazars", **Sagnick Mukherjee**, Kaustav Mitra, and Ritaban Chatterjee (**2019**, Monthly Notices of the Royal Astronomical Society, Volume 486, Issue 2)

9. "X-Ray Surface Brightness Profiles of Optically Selected Active Galactic Nuclei: Comparison with X-Ray AGNs", **Sagnick Mukherjee**, Anirban Bhattacharjee, Suchetana Chatterjee, Jeffrey A. Newman, and Renbin Yan (**2019**, The Astrophysical Journal, Volume 872, Number 1)

2nd & 3rd-Authored Publications

1. "Disequilibrium Chemistry, Diabatic Thermal Structure, and Clouds in the Atmosphere of COCONUTS-2b", Zhang, Zhoujian; **Mukherjee, Sagnick**; Liu, Michael C.; et al. (**2024**, AJ, in press)

2. "A Tale of Two Molecules: The Underprediction of CO 2 and Overprediction of PH 3 in Late T and Y Dwarf Atmospheric Models", Beiler, Samuel A. ; **Mukherjee, Sagnick** ; Cushing, Michael C., et al. (**2024**, ApJ, in press)

3. "The atmosphere of HD 149026b: Low metal-enrichment and weak energy transport", Anna Gagnebin, **Sagnick Mukherjee**, Jonathan J. Fortney, Natasha E. Batalha. (**2024**, ApJ)

4. "Multiple Clues for Dayside Aerosols and Temperature Gradients in WASP-69 b from a Panchromatic JWST Emission Spectrum" Schlawin, Everett ; **Mukherjee, Sagnick** ; Ohno, Kazumasa ; Bell, Taylor., et al. (**2024**, AJ)

5. "High-Precision Atmospheric Constraints for a Cool T Dwarf from JWST Spectroscopy", Hood, Callie E. ; **Mukherjee, Sagnick** ; Fortney, Jonathan J. ; Line, Michael R. ; Faherty, Jacqueline K.,et al. (**2024**, Nature Astronomy, Under Review)

6. "The Sonora Substellar Atmosphere Models. III. Diamondback: Atmospheric Properties, Spectra, and Evolution for Warm Cloudy Substellar Objects" Morley, Caroline V. ; **Mukherjee, Sagnick** ; Marley, Mark S. ; Fortney, Jonathan J., et al. (**2024**, ApJ, in press)

7. "Early Release Science of the exoplanet WASP-39b with JWST NIRSpec PRISM", Rustamkulov, Z. ; Sing, D. K. ; **Mukherjee, Sagnick** ; May, E. M., et al. (**2023**, Nature)

8. "The Infrared Colors of 51 Eridani b: Micrometeoroid Dust or Chemical Disequilibrium?", Madurowicz, Alexander; **Mukherjee, Sagnick**; Batalha, Natasha E., et al., (**2022**, AJ)

9. "Witnessing the early evolution of a young sub-Neptune progenitor", Barat, Saugata; Désert, Jean-Michel; **Mukherjee**, Sagnick, et al., (in preparation for ApJL, 2024)

Other Co-Authored Publications

1. "Statistical trends in JWST transiting exoplanet atmospheres", Fu, Guangwei; Stevenson, Kevin B.; Sing, David K.; **Mukherjee, Sagnick**, et al. (ApJ, in press)
2. "Quartz Clouds in the Dayside Atmosphere of the Quintessential Hot Jupiter HD 189733 b", Inglis, Julie; Batalha, Natasha E.,..., **Mukherjee, Sagnick**, et al. (**2024**, ApJL, in press)
3. "Precise Bolometric Luminosities and Effective Temperatures of 23 late-T and Y dwarfs Obtained with JWST", Beiler, Samuel A. ; Cushing, Michael C. ; Kirkpatrick, J. Davy ; Schneider, Adam C. ; **Mukherjee, Sagnick**, et al. (**2024**, AAS journals, in press)
4. "Sulfur Dioxide and Other Molecular Species in the Atmosphere of the Sub-Neptune GJ 3470 b ", Beatty, Thomas G. ; Welbanks, Luis ; Schlawin, Everett ;..., **Mukherjee, Sagnick**, et al. (**2024**, ApJL)
5. "The Complete CEERS Early Universe Galaxy Sample: A Surprisingly Slow Evolution of the Space Density of Bright Galaxies at z 8.5–14.5" Finkelstein, Steven L. ; Leung, Gene C. K. ; Bagley, Micaela B.,...,**Mukherjee, Sagnick**; et al. (**2024**, ApJL)
6. "JWST/NIRCam 4-5 μ m Imaging of the Giant Planet AF Lep b", Franson, Kyle ; Balmer, William O. ; Bowler, Brendan P. ; Pueyo, Laurent ;..., **Mukherjee, Sagnick**, et al. (**2024**, ApJL)
7. "Probing the Heights and Depths of Y Dwarf Atmospheres: A Retrieval Analysis of the JWST Spectral Energy Distribution of WISE J035934.06−540154.6", Kothari, Harshil ; Cushing, Michael C. ; Burningham, Ben ;..., **Mukherjee, Sagnick**, et al. (**2024**, ApJ)
8. "High-precision Atmospheric Characterization of a Y Dwarf with JWST NIRSpec G395H Spectroscopy: Isotopologue, C/O Ratio, Metallicity, and the Abundances of Six Molecular Species", Lew, Ben W. P. search by orcid ; Roellig, Thomas ;..., **Mukherjee, Sagnick**, et al. (**2024**, AJ)
9. "A high internal heat flux and large core in a warm Neptune exoplanet", Welbanks, Luis ; Bell, Taylor J. ; Beatty, Thomas G. ; Line, Michael R. ;..., **Mukherjee, Sagnick**, et al. (**2024**, Nature)
10. "The JWST Early Release Science Program for Direct Observations of Exoplanetary Systems. V. Do Self-consistent Atmospheric Models Represent JWST Spectra? A Showcase with VHS 1256–1257 b", Petrus, Simon ; Whiteford, Niall ; Patapis, Polychronis ; Biller, Beth A.;..**Mukherjee, Sagnick**;..., et al., (**2024**, ApJ)
11. "Sulfur dioxide in the mid-infrared transmission spectrum of WASP-39b", Powell, Diana ; Feinstein, Adina D. ; Lee, Elspeth K. H;...,**Mukherjee, Sagnick**;..., et al. (**2024**, Nature)
12. "Methane throughout the atmosphere of the warm exoplanet WASP-80b", Bell, Taylor J. ; Welbanks, Luis ; Schlawin, Everett ; Line, Michael R. ; Fortney, Jonathan J.;...,**Mukherjee, Sagnick**;...,et al. (**2023**, Nature)
13. "The *JWST* Early Release Science Program for Direct Observations of Exoplanetary Systems III: Aperture Masking Interferometric Observations of the star HIP 65426 at 3.8μm", Ray, Shrishmoy ; Sallum, Steph ; Hinkley, Sasha;...,**Mukherjee, Sagnick**, et al. (**2023**, ApJL)

14. "Awesome SOSS: transmission spectroscopy of WASP-96b with NIRISS/SOSS", Radica, Michael ; Welbanks, Luis ; Espinoza, Néstor ; Taylor, Jake;...,**Mukherjee, Sagnick**, et al. (**2023**, MNRAS)

15. "The First JWST Spectral Energy Distribution of a Y Dwarf", Beiler, Samuel A. ; Cushing, Michael C. ; Kirkpatrick, J. Davy ; Schneider, Adam C. ; **Mukherjee, Sagnick** ; Marley, Mark S. (**ApJL**, 2023)

16. "The JWST Early Release Science Program for Direct Observations of Exoplanetary Systems I: High-contrast Imaging of the Exoplanet HIP 65426 b from 2 to 16 μm", Carter, Aarynn L. ; Hinkley, Sasha ; Kammerer, Jens ; Skemer, Andrew;...,**Mukherjee, Sagnick**, et al. (**2023**, ApJL)

17. "Photochemically produced SO2 in the atmosphere of WASP-39b", Tsai, Shang-Min ; Lee, Elspeth K. H. ; Powell, Diana ; Gao, Peter;...,**Mukherjee, Sagnick**, et al. (**2023**, Nature)

18. "The JWST Early-release Science Program for Direct Observations of Exoplanetary Systems II: A 1 to 20 μm Spectrum of the Planetary-mass Companion VHS 1256-1257 b", Miles, Brittany E. ; Biller, Beth A. ; Patapis, Polychronis;...,**Mukherjee, Sagnick**, et al. (**2023**, ApJL)

19. "First Observations of the Brown Dwarf HD 19467 B with JWST", Greenbaum, Alexandra Z. ; Llop-Sayson, Jorge ; Lew, Ben W. P.;..., **Mukherjee, Sagnick**, et al. (**2023**, ApJ)

20. "Early Release Science of the exoplanet WASP-39b with JWST NIRISS", Feinstein, Adina D. ; Radica, Michael ; Welbanks, Luis;...,**Mukherjee, Sagnick**, et al. (**2023**, Nature)

21. "Early Release Science of the exoplanet WASP-39b with JWST NIRSpec G395H", Alderson, Lili ; Wakeford, Hannah R. ; Alam, Munazza K. ; Batalha, Natasha E.;...,**Mukherjee, Sagnick**, et al. (**2023**, Nature)

22. "Early Release Science of the exoplanet WASP-39b with JWST NIRCam", Ahrer, Eva-Maria ; Stevenson, Kevin B. ; Mansfield, Megan ; Moran, Sarah E.;...,**Mukherjee, Sagnick**, et al. (**2023**, Nature)

23. "Identification of carbon dioxide in an exoplanet atmosphere", JWST Transiting Exoplanet Community Early Release Science Team (including **Mukherjee, Sagnick**), (**2023**, Nature)

24. "A Clear View of a Cloudy Brown Dwarf Companion from High-resolution Spectroscopy", Xuan, Jerry W. ; Wang, Jason ; Ruffio, Jean-Baptiste,...,**Mukherjee, Sagnick**, et al. (**2022**, ApJ)

25. "PHAT XX. AGB Stars and Other Cool Giants in M31 Star Clusters", Girardi, Léo ; Boyer, Martha L. ; Johnson, L. Clifton ; Dalcanton, Julianne J.,...,**Mukherjee, Sagnick**, et al. (**2020**, ApJ)

Colloquia and Seminars

1. 'Constraints on Atmospheric Mixing in Brown Dwarf and Exoplanet Atmospheres in the JWST Era', Februrary 2024, Carnegie Earth and Planets Laboratory, Washington DC.

2. 'Constraints on Atmospheric Mixing in Brown Dwarf and Exoplanet Atmospheres in the JWST Era', November 2023, CTC Seminar, University of Maryland, College Park.

3. 'Constraints on Atmospheric Mixing in Brown Dwarf and Exoplanet Atmospheres in the JWST Era', November 2023, Dept. of Astronomy, Cornell University, Ithaca.

4. 'Constraints on Atmospheric Mixing in Brown Dwarf and Exoplanet Atmospheres in the JWST Era', October 2023, School of Earth and Planetary Sciences, NISER Bhubaneswar, India.

5. ‘Constraints on Atmospheric Mixing in Brown Dwarf and Exoplanet Atmospheres in the JWST Era’, November 2023, Department of Astrophysics and High Energy Physics, SNBNCBS, Kolkata, India.

6. ‘Constraints on Atmospheric Mixing in Brown Dwarf and Exoplanet Atmospheres in the JWST Era’, July 2023, Imperial College London, London.

7. ‘Constraining Vertical Mixing, Metallicity, and C/O Ratio of Giant Planet and Brown Dwarf Atmospheres”, March 2023, SESE, Arizona State University, Tempe.

8. ‘Understanding Exoplanet and Brown Dwarf Atmospheres in the JWST Era’, June 2022, CESSI Seminar, IISER Kolkata.

Conference, Talks and Posters

1. Contributed Talk, ‘Effects of Planetary Parameters on Disequilibrium Chemistry: From Gas Giants to Sub-Neptunes’, July 2024, Challenge Accepted! Linking Planet Formation with Present-Day Atmospheres, MPIA Heidelberg, Germany.

2. Contributed Talk, ‘Revisiting GJ 436b’s Atmosphere with Panchromatic JWST Emission Spectroscopy’, June 2024, Exoplanets V, Leiden, Netherlands.

3. Contributed Talk, ‘PICASO: An Unified Atmospheric Model of Exoplanetary Atmospheres with Photochemistry and Vertical Mixing’, June 2023, ERES Conference, Yale University.

4. Poster Presentation, ‘Constraints on Atmospheric Vertical Mixing in Giant Exoplanets and Brown Dwarfs’, September 2023, Exoplanets: Atmospheres to Architecture, Washington DC.

5. Poster Presentation, ‘PICASO: An Unified Atmospheric Model of Exoplanetary Atmospheres with Photochemistry and Vertical Mixing’, June 2023, Exoclimes Conference, University of Exeter.

6. Contributed Talk , ’Atmospheric and Evolutionary Models of Substellar Objects with Disequilibrium Chemistry for the JWST Era’, January 2023, AAS Conference, Seattle.

7. Contributed Talk , ’Atmospheric and Evolutionary Models of Substellar Objects with Disequilibrium Chemistry for the JWST Era’, January 2023, ExoPAG 27, Seattle.

8. Contributed Talk , ‘PICASO 3.0: A One-Dimensional Open Source Climate Model for Giant Planets and Brown Dwarfs’, October 2022, 42nd Bay Area Exoplanets Meeting, SETi.

9. Contributed Talk , ‘Understanding Atmospheric Mixing with Disequilibrium Chemistry in Brown Dwarfs’, July 2022, Other Worlds Laboratory (OWL) Summer Program.

10. Poster Presentation, ’Measuring Vertical Mixing in Giant Planets and Brown Dwarf Atmospheres’, September 2023, Ninth Annual Giant Magellan Telescope Community Science Meeting, Washington DC.

11. Poster Presentation, ’PICASO+VULCAN: Modeling Exoplanetary Atmospheres Self-Consistently with Photochemistry and Vertical Mixing’, June 2023, Exoclimes VI, June 2023, University of Exeter, UK.

12. Poster Presentation, ’Probing Atmospheric Mixing with Disequilibrium Chemistry in Brown Dwarfs and Warm Exoplanets’, May 2022, Exoplanets IV, Las Vegas.

13. Contributed Talk , 'Understanding Atmospheric Mixing with Disequilibrium Chemistry in Brown Dwarfs', January 2022, CHAMPs Exoplanet Early Career Seminar.

14. Contributed Talk , 'Modeling Polarization Signals from Cloudy Brown Dwarfs: Luhman 16 A and B in Three Dimensions', September 2021, Bay Area Exoplanet Meeting 38.

15. Poster Presentation, 'Modeling Polarization signals in 3D from brown dwarfs Luhman 16 and B', April 2021, STScI Spring Symposium

16. Contributed Talk , 'Cloud Complexity Required for Retrievals on Reflected Spectroscopy of Cool Giants', September 2020, Bay Area Exoplanet Meeting 34.

17. Contributed talk, 'The accretion disc-jet connection in blazars', 37th Annual meeting of the Astronomical Society of India , Christ University, Bangalore, Spring 2019

Awards and Fellowships

1. Templeton Theory-Experiment Cross Training (TEX) fellowship co-hosted by UCSC and JHU.

2. UC President's Lindau Fellow 2024, Participant in the 73rd Lindau Nobel Laureate Meeting (Physics), July 2024, Lindau, Germany.

3. Barbara Walker Best Paper Award 2023-24 for "PICASO 3.0: A One-dimensional Climate Model for Giant Planets and Brown Dwarfs".

4. UC Regent's fellowship for first year graduate study at Department of Astronomy and Astrophysics, UCSC.

5. 2021-2022 Whitford Prize for highest achievement in research, coursework, and teaching as a 2nd year Graduate Student in the Astronomy department at UCSC.

6. Awarded the S.N. Bose Scholarship from Indo-US Science and Technology Forum (IUSSTF), 2019 for participating in short-term summer research at University of California, Santa Cruz.

7. Stood first in M.Sc Physics (Gold medalist) (2018-2020) and B.Sc Physics (Gold Medalist) (2015-18).

8. INSPIRE fellow, Department of Science and Technology, Government of India.

9. Jagadis Bose National Science Talent Search scholarship for undergraduate research (2015-2020).

Grants & Observing Proposal Awards

1. Co-PI and theory lead of Awarded James Webb Space Telescope Cycle 2 time for the GO program 4094 named "Probing the Depths: Disequilibrium Chemistry as a Tracer of Mixing Processes in Brown Dwarf Atmospheres".

2. PI of Awarded James Webb Space Telescope Cycle 2 AR GO program 3245 named "Up to the Task? A New Generation of Atmospheric and Interior Models of Brown Dwarfs for the JWST Era".

3. Co-I of Awarded James Webb Space Telescope Cycle 3 Large GO program 5959 named "KRONOS: Keys to Revealing the Origin and Nature Of sub-neptune Systems"

4. Co-I of Awarded James Webb Space Telescope Cycle 3 GO program 6122 named "Cool kids on the block: The direct detection of cold ice giants and gas giants orbiting young low-mass neighbors"

5. Co-I of Awarded James Webb Space Telescope Cycle 2 AR GO program 3201 named "The Utility of Self-Consistent Models and Photochemistry in Understanding Transiting Planet Atmospheres"

6. Co-I of Awarded uGMRT Cycle 47 GO program named "Investigating the Auroral Heating of Brown Dwarf Atmosphere with uGMRT and JWST"

7. Co-I of Awarded uGMRT Cycle 47 GO program named "Can rogue super-Jupiters be radio-bright? A search for radio emission from at the deuterium burning limit"

8. Awarded Hubble Space Telescope Cycle 30 GO time for the proposal "Photometry of a Young Planetary-Mass Companion to a Taurus M Dwarf Star" (Co-I).

Teaching and Mentoring Experience

1. Mentoring undergraduate student Anna Gagnebin (California State University, Sacramento) for the project "Exoplanet Atmosphere Models for JWST Spectroscopy", 2022.

2. Teaching Assistant for ASTR-10 "From the Big Bang to Planet Earth" with Prof. Alexie Leauthead, Spring 2023.

3. Teaching Assistant for ASTR-16 "Astrobiology: Life in the Universe" with Prof. Natalie Batalha, Fall 2021.

4. Mentored 6 high school students for the astronomy project "Photometrically variable stars in M31" as a part of the Science Internship Program (SIP) 2019 and 2020.

Professional Service

1. Referee for multiple publications in The Astrophysical Journal and Astronomy and Astrophysics

2. Served as Reviewer for NASA panels.

3. Served as a trainer for the `PICASO` software in the Sagan Summer Workshop, 2023.

4. Served as a mentor for the `PICASO` hands-on session in the Sagan Summer Workshop, 2021.

Press Coverage

1. "India's Space Success Continues: Know All About Indian Scientists Awarded Webb Telescope Usage Time In Cycle 2", The Weather Channel, August 24, 2023

2. "Methane Throughout The Atmosphere Of The Warm Exoplanet WASP-80b", Astrobiology, September 7, 2023

3. "JWST makes first unequivocal detection of carbon dioxide in an exoplanet atmosphere", UCSC Newscenter, August 25, 2022

4. "James Webb telescope detects dust storm on distant world", BBC News, March 22, 2023.

5. "NASA's Webb Detects Carbon Dioxide in Exoplanet Atmosphere", NASA JPL, August 25, 2022. Also covered by leading news platforms across the world.

6. "JWST's First Direct Spectrum of a Planetary-Mass Object", Astrobites, September 2, 2022,

7. "NASA releases Webb telescope's first exoplanet image", UCSC Newscenter, September 1, 2022. Also covered by leading news platforms across the world.
8. "James Webb Space Telescope: Carbon Dioxide in an Atmosphere which is 700 light years away", Anandabazar Patrika, August 27, 2022

Scientific Computing Experience

1. Developed the open-source atmospheric model `PICASO 3.0` for exoplanets and brown dwarfs
2. 5 years experience with exoplanet atmospheric simulation package `PICASO`.
3. Contributed to development of exoplanet cloud modeling package `VIRGA`.
4. Proficient scientific programming with Python and Fortran.
5. Proficient in GPU based Python programming with Numba Cuda and CuPy.
6. Selected and Participated in the NASA GPU Hackathon 2022 co-organised by NASA and NVIDIA.