

# Ramanakumar Sankar

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## Postdoctoral researcher

University of California, Berkeley

2023 -

Working on understanding fluid dynamics and cloud chemistry of Solar System gas giant planets. I am running numerical fluid dynamics models to study the diversity of convective features across the jovian atmosphere and using computer vision-based neural network models to do a data-driven study of jovian atmospheric dynamics.

## EDUCATION

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2016 - 2021

### Ph.D. in Space Sciences

Florida Institute of Technology

Researching Jovian atmospheric dynamics and adding sub grid-scale moist-convective parameterization to the EPIC model

Dissertation title: *A Numerical Study of Jovian Moist Convection with a new Convective Adjustment Scheme, and Implications for Jupiter's Water Abundance*

2012 - 2016

### B.S. Astronomy & Astrophysics, Dual Major in B.S. Mathematical Sciences

Florida Institute of Technology

Graduated *cum laude*

## RESEARCH EXPERIENCE

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2022 -

### Studying convective cloud formation on Jupiter using numerical simulations

Studying the nature of convection on Jupiter using the EPIC Gas Giant atmospheric model. I am working on understanding the structure of the deep atmosphere on Jupiter, and identifying key processes that form convective outbreaks. I am leading the effort to update the model with a more robust microphysical formulation of cloud particles, so that cloud formation is treated more accurately, and using this to study the differences between regions that are conducive of convective activity, compared to those that are not.

2021 -

### Applying machine-learning algorithms and citizen science to study the jovian atmosphere

Developing a Convolutional Variational AutoEncoder (CVAE) neural network to determine and cluster/classify cloud features from *JunoCam* images of Jupiter. I lead the Jovian Vortex Hunter project on Zooniverse to study the diversity of vortices on Jupiter in order to understand the relation between the observed cloud features and the underlying dynamics and atmospheric structure. I am currently extending the work to Hubble Space Telescope datasets by using a style-transfer GAN to study spectral signatures of convective clouds.

2021 - 2023

### Studying human-computer optimization techniques for citizen science projects on Zooniverse

Working on deep learning techniques for accelerating serendipitous discoveries from citizen science projects. I am involved in designing novel deep learning frameworks that can be used to reduce workload of human volunteers on citizen science projects, by increasing the efficiency of classifications on easy tasks using machine models. Human efforts can then be directed towards identifying scientifically interesting subjects.

## PUBLICATIONS

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### *Journal publications*

- Brueshaber, S. R., Zhang, Z., Rogers, J. H., Eichstädt, G., Orton, G. S., Grassi, D., Fletcher, L. N., Li, C., Mizumoto, S., Mura, A., Oyafuso, F., **Sankar, R.**, Wong, M. H., Hansen, C. J., Levin, S. and Bolton, S. . 2025. "Multi-instrument sounding of a Jovian thunderstorm from Juno". *Icarus*, 116465. DOI: [10.1016/j.icarus.2025.116465](https://doi.org/10.1016/j.icarus.2025.116465)
- **Sankar, R.**, Mantha, K., Nesmith, C., Fortson, L., Brueshaber, S., Hansen-Koharcheck, C. and Orton, G. . 2024. Understanding Confusion: A Case Study of Training a Machine Model to Predict and Interpret Consensus From Volunteer Labels. *Citizen Science: Theory and Practice*, 44. DOI: [10.5334/cstp.731](https://doi.org/10.5334/cstp.731)
- Mantha, K. B., Roberts, H., Fortson, L., Lintott, C., Dickinson, H., Keel, W., **Sankar, R.**, Krawczyk, C., Simmons, B., Walmsley, M., Garland, I., Makechemu, J. S., Trouille, L. and Johnson, C. . 2024. Through the Citizen Scientists' Eyes: Insights into Using Citizen Science with Machine Learning for Effective Identification of Unknown-Unknowns in Big Data. *Citizen Science: Theory and Practice*, 40. DOI: [10.5334/cstp.740](https://doi.org/10.5334/cstp.740)
- **Sankar, R.**, Brueshaber, S., Fortson, L., Hansen-Koharcheck, C., Lintott, C., Mantha, K., Nesmith, C. and Orton, G. S. 2024. Jovian Vortex Hunter: A Citizen Science Project to Study Jupiter's Vortices. *Planetary Science Journal*. 5, 203 DOI: [10.3847/PSJ/ad6e75](https://doi.org/10.3847/PSJ/ad6e75)
- **Sankar, R.**, Mantha, K., Fortson, L., Spiers, H., Pengo, T., Mashek, D., Mo, M., Sanders, M., Christensen, T., Salisbury, J. and Trouille, L. . 2023. TCuPGAN: A novel framework developed for optimizing human-machine interactions in citizen science. DOI: [10.48550/arXiv.2311.14177](https://doi.org/10.48550/arXiv.2311.14177)
- Palotai, C., Brueshaber, S., **Sankar, R.** and Sayanagi, K. 2022. Moist Convection in the Giant Planet Atmospheres. *Remote Sensing*. 15. 219. DOI: [10.3390/rs15010219](https://doi.org/10.3390/rs15010219) (review paper)
- Mantha, K. B., **Sankar, R.**, Zheng, Y., Fortson, L., Pengo, T., Mashek, D., Sanders, M., Christensen, T., Salisbury, J., Trouille, L., Byrnes, J. E. K., Rosenthal, I., Houskeeper, H. and Cavanaugh, K. 2022. From fat droplets to floating forests: cross-domain transfer learning using a PatchGAN-based segmentation model. DOI: [10.48550/ARXIV.2211.03937](https://doi.org/10.48550/ARXIV.2211.03937)
- **Sankar, R.** and Palotai, C. 2022. A new convective parameterization applied to Jupiter: Implications for water abundance near the 24°N region. *Icarus* 380, 114973 DOI: [10.1016/j.icarus.2022.114973](https://doi.org/10.1016/j.icarus.2022.114973)
- **Sankar, R.**, Klare, C. and Palotai, C. 2021. The aftermath of convective events near Jupiter's fastest prograde jet: Implications for clouds, dynamics and vertical wind shear. *Icarus*. 368, 114589. DOI: [10.1016/j.icarus.2021.114589](https://doi.org/10.1016/j.icarus.2021.114589)
- Hadland, N., **Sankar, R.**, LeBeau, R. P. and Palotai, C. 2020. EPIC simulations of Neptune's dark spots using an active cloud microphysical model. *Monthly Notices of the RAS*. 496, 4760-4768. DOI: [10.1093/mnras/staa1799](https://doi.org/10.1093/mnras/staa1799)
- **Sankar, R.**, Palotai, C., Hueso, R., Delcroix, M., Chappel, E. and Sánchez-Lavega, A. 2020. Fragmentation modelling of the 2019 August impact on Jupiter. *Monthly Notices of the RAS*. 493, 4622-4630. DOI: [10.1093/mnras/staa563](https://doi.org/10.1093/mnras/staa563)

### *Selected conference abstracts and non peer-reviewed publications*

- **Sankar, R.**, Wong, M. and Palotai, C. . 2024. "Convective energy generation on Jupiter dominated by eddy material transport". *AAS/Division for Planetary Sciences Meeting Abstracts*
- **Sankar, R.**, Wong, M. H. and Palotai, C. J. . 2023. "Jovian moist convection: a numerical study from a cloud microphysics perspective". *AGU Fall Meeting Abstracts*
- **Sankar, R.**, Wong, M. and Palotai, C. . 2023. "How are Jupiter's belts and zones affected by deep convection: a parameterized numerical study". *AAS/Division for Planetary Sciences Meeting Abstracts #55*
- **Sankar, R.**, Fortson, L., Mantha, K., Johnson, L. and Trouille, L. . 2022. "Build citizen science projects: a demonstration of the Zooniverse Project Builder tool". *AAS/Division for Planetary Sciences Meeting Abstracts*
- **Sankar, R.**, Wong, M. and Palotai, C. 2023. "How are Jupiter's belts and zones affected by deep convection: a parameterized numerical study". *AAS/Division for Planetary Sciences Meeting Abstracts*
- **Sankar, R.**, Fortson, L., Mantha, K., Johnson, L. and Trouille, L. 2022. Build citizen science projects: a demonstration of the Zooniverse Project Builder tool. *AAS/Division for Planetary Sciences Meeting Abstracts*
- **Sankar, R.**, Brueshaber, S., Fortson, L., Hansen, C., Lintott, C., Mantha, K. and Orton, G. 2022. Crowd-sourced clouds: Using Citizen Science to study vortices on Jupiter. *AAS/Division for Planetary Sciences Meeting Abstracts*

## SKILLS

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### *Programming*

- Proficient in Python, C and C++
- Working proficiency in MATLAB, FORTRAN and R
- Extensive experience with the EPIC atmospheric model
- Proficient in numerical techniques for fluid/atmospheric modeling
- Experience with big data analysis and machine learning (using scikitlearn/Keras/TensorFlow/PyTorch)
- Experience with radiative transfer modeling using PyDISORT
- Other programming skills: Bash, HTML/CSS, PHP, JavaScript/React,  $\LaTeX$ , Git
- Experience with using VisIt and ParaView for data visualization
- Experience in server hardware management and Linux system administration

## TEACHING AND MENTORING EXPERIENCE

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- Taught Introduction to Astronomy Summer 6-week course for college freshmen and high school seniors at University of California, Berkeley.
- Led workshop on data science and machine learning with Python for the University of Minnesota's Data Science in Multi-Messenger Astrophysics 2023 cohort.
- Teaching assistant at Florida Tech for
  - Introductory Physics labs (Fall 2016 - Spring 2018). Taught freshmen level physics, experimental Newtonian mechanics, error analysis and lab report writing
  - Observational Astronomy lab (Spring 2018). Helped train students with the use of Meade 8" telescopes and data reduction techniques
- Mentoring undergraduate and graduate students in scientific computing and planetary science research. Involved in teaching programming techniques for research, e.g., Python, machine learning, deep learning (Tensorflow and PyTorch), parallel computing, EPIC modeling.

## OUTREACH

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- Presented several public facing talks at planetariums and astronomy clubs
- Public correspondence (writing blogs, addressing volunteer comments, communication on social media, etc.) as lead of the Jovian Vortex Hunter project on Zooniverse
- Co-led department outreach activities, including setting up telescopes for monthly public viewing and high school tours
- Host of 'Science Coffee' at Florida Tech– weekly journal club meeting to discuss ongoing research in department and new publications in related fields

## INVITED TALKS

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Whatcom Astronomy Public Talk Series	May 2024
Center for Integrative Planetary Sciences seminar (UC Berkeley)	Apr 2024
NASA Langley Weekly Lecture Series	May 2023
Minnesota Institute for Astrophysics Colloquium	Oct 2021

## OBSERVING EXPERIENCE

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- Experience with using the Ortega 32" telescope at Florida Tech
- Proficient in using the lucky-imaging technique to process and reduce images

## **MEETINGS/WORKSHOPS ATTENDED**

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- Division for Planetary Sciences meetings 2016-2023
- Europlanet Science Congress 2020, 2021
- Outer Planet Assessment Group 2020
- American Geophysical Union Fall Meeting 2019, 2020, 2022-2023
- JWST Proposal Preparation Workshop, University of Central Florida, Orlando 2020

## **AWARDS AND ACCOMPLISHMENTS**

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- Reviewed for Planetary Science Journal, Icarus, Nature Astronomy, Journal of Geophysical Research Letters, Monthly Notices of the Royal Astronomical Society and the Citizen Science Theory and Practice
- Recipient of 2019 NASA FINESST grant
- Awarded the 2019 Outstanding Graduate Student of the Year in Physics/Space Sciences Dept. at Florida Tech

## **PROFESSIONAL MEMBERSHIPS**

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- Member of the American Astronomical Society (Division of Planetary Sciences)
- Member of Sigma Pi Sigma honor society
- Member of Phi Kappa Phi honor society

Languages: Fluent in English and Tamil. Others (in order of fluency): French, Kannada and Swahili