

# Aarya Patil

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Max Planck Institute for Astronomy (MPIA), Germany

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## RESEARCH INTERESTS

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My research lies at the intersection of astrophysics, statistics, and computer science. I develop novel data-driven tools to guide models of the Milky Way galaxy. My goal is to use these models to understand how galaxies form and evolve.

## EDUCATION

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- 2023 **University of Toronto**, Direct-Entry PhD in Astronomy & Astrophysics Canada  
Thesis title: Order in Chaos - Decoding the age-metallicity structure of the Milky Way disk  
Supervisors: Jo Bovy & Gwendolyn Eadie
- 2018 **S. P. Pune University**, BEng in Computer Engineering (CGPA: 9.45/10) India

## PROFESSIONAL APPOINTMENTS

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- 2023 - Present **LSST Discovery Alliance (LSST-DA) Catalyst Fellow**, MPIA  
Mentors: Hans-Walter Rix & Ivelina Momcheva
- Summer 2017 **Developer**, [Google Summer of Code](#) (GSoC) Participant with OpenAstronomy/Astropy  
Mentors: T. Aldcroft (Harvard-Smithsonian), M. van Kerkwijk (U. of Toronto) & H. M. Günther (MIT)

## PUBLICATIONS

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### Refereed

#### Published:

- 2023 **Patil, A. A.**; Bovy, J.; Jaimungal, S.; Frankel, N.; & Leung, H. W. “Decoding the age-chemical structure of the Milky Way disc: an application of copulas and elicitable maps”. Monthly Notices of the Royal Astronomical Society, Volume 526, Issue 2, pp.1997-2016 [[arXiv/2306.09319](#)]
- 2022 **Patil, A. A.**; Bovy, J.; Eadie, G.; & Jaimungal, S. “Functional Data Analysis for Extracting the Intrinsic Dimensionality of Spectra: Application to Chemical Homogeneity in the Open Cluster M67”. The Astrophysical Journal, Volume 926, Issue 1, article id. 51, 24pp. [[arXiv/2109.10891](#)] [[4 citations](#)]
- 2022 The Astropy Collaboration, Price-Whelan, A. M.; Lim, P. L.; Earl, N.; Starkman, N.; Bradley, L.; Shupe, D. L.; **Patil, A. A.** et al. “The Astropy Project: Sustaining and Growing a Community-oriented Open-source Project and the Latest Major Release (v5.0) of the Core Package”. The Astrophysical Journal, Volume 935, Issue 2, article id 167, 20pp. [[arXiv/2206.14220](#)] [[1014 citations](#)]
- 2018 The Astropy Collaboration et al. incl. **Patil, A. A.** “The Astropy Project: Building an Open-science Project and Status of the v2.0 Core Package”. The Astronomical Journal, Volume 156, Issue 3, article id. 123, 19pp. [[arXiv/1801.02634](#)] [[5906 citations](#)]

#### Submitted:

**Patil, A. A.**; Eadie, G.; Speagle, J.; & Thomson, D. “Improving Power Spectrum Estimation using Multitapering I: Efficient asteroseismic analyses for understanding stars, the Milky Way, and beyond”. Submitted to The Astronomical Journal, 32 pp. [[arXiv/2209.15027](#)][[2 citations](#)]

## In preparation:

**Patil, A. A.**; Eadie, G.; Speagle, J.; & Thomson, D. “Improving Power Spectrum Estimation using Multitapering II: Precise mode parameter estimation using the F-test”. To be submitted to The Astronomical Journal in February 2024.

Sun, J.\*; **Patil, A. A.**; Li, Y.; Guo, J.; & Zhou, S. “How to Sustain a Scientific Open-Source Software Ecosystem: Learning from the Astropy Project”. To be submitted to the [IEEE/ACM International Conference on Software Engineering](#) in March 2024. <sup>\*</sup>mentee

## Non-refereed

### Conference Proceedings:

2020 **Patil, A.**; Bovy, J.; & Eadie G. “[Likelihood-free Inference of Chemical Homogeneity in Open Clusters](#)”. Joint Statistical Meetings Proceedings, ASA, pp 1838-1844.

### Software:

2022 **Patil, A.** “aaryapatil/tapify: v0.1.0”. Zenodo. [doi.org/10.5281/zenodo.7312220](https://doi.org/10.5281/zenodo.7312220)

2022 Cruz, K.; Günther, H. M.; **Patil, A.**; Swinbank, J.; & Tollerud, E. “Astropy Proposal for Enhancement 19: Distributing Astropy Project Funding (APE19)”. Technical Report, Zenodo. [doi.org/10.5281/zenodo.6312048](https://doi.org/10.5281/zenodo.6312048)

2021 Robitaille, T. et al. incl. **Patil, A.** “astropy/astropy: v4.2.1”, Zenodo. [doi.org/10.5281/zenodo.4670729](https://doi.org/10.5281/zenodo.4670729)

## MAJOR FELLOWSHIPS & AWARDS

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2024	<b>Best Astrostatistics Student Paper Finalist</b> (one of 5 finalists)	finals in August
	American Statistical Association (ASA)/Astrostatistics Interest Group, award for <a href="#">Patil et al. (2023)</a>	
2026 - 2027	<b>MPIA Postdoctoral Fellowship</b>	
	MPIA, catalyst fellowship extension	
2023 - 2026	<b>LSST-DA Catalyst Fellowship</b>	USD 72,100/year
	LSST Discovery Alliance, independent fellowship with USD 15k research budget/year	
2022 - 2023	<b>Data Sciences Institute Doctoral Student Fellowship</b>	CAD 25,000/year
	Data Sciences Institute, University of Toronto (UofT), up to 3 years of funding	
2022	<b>Best Astrostatistics Student Paper Finalist</b> (one of 5 finalists)	USD 1,100
	ASA/Astrostatistics Interest Group, award for <a href="#">Patil et al. (2022)</a>	
2021 - 2022	<b>International Graduate Student Doctoral Fellowship</b>	CAD 3,000
	D. A. D. Dept. of Astronomy & Astrophysics (DADDAA), UofT	
2021	<b>Delta Kappa Gamma World Fellowship Runner-up</b>	
	International World Fellowship Committee, Delta Kappa Gamma	
2018 - 2023	<b>University of Toronto Fellowships</b>	CAD 80,000
2018 - 2021	<b>Massey College UofT Junior Fellowship</b>	CAD 11,000
2017	<b>ABU ROBOCON 2017 - All India Rank 10</b> out of 125 teams	
	Programming Head, Pune Institute of Computer Technology Robotics Team	

## MAJOR GRANTS

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2022 - 2023	<b>Astropy Cycle III Funding Grant</b>	USD 20,220
	Co-Investigator (Co-I): “Python/Astropy Training School in Bulgaria” (\$8,670)	
	Lead: “Pan-African School for Emerging Astronomers (PASEA) 2022 in Zambia” (\$11,550)	

2022 - 2023	<b>Dunlap Institute (UofT) Seed Funding Grants</b>	CAD 35,968
	Co-I: "PASEA 2022 in Zambia" (\$29,100)	
	Co-I: "Intertwining Dunlap/UofT & Sustainable Open-Source Software via Astropy" (\$6,868)	

## PRESENTATIONS

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### Invited

2024	<b>Königstuhl Colloquium</b> , Feb. 16	Heidelberg, Germany
	"Understanding the formation history of the Milky Way galaxy using astrostatistics"	
2024	<b>243rd meeting of the American Astronomical Society</b> , Jan. 8	New Orleans, USA
	Expert panelist: "Building on 25 Years of Community Organization in Astro Software Development"	
2023	<b>Toronto Astrophysics Talks, Y'all (TASTY)</b> , Nov. 2023	Toronto, Canada
	"Building a unified model of the Milky Way galaxy"	
2023	<b>LSST Discovery Alliance Catalyst Symposium</b> , Oct. 23	Tucson, USA
	"Building a unified model of the Milky Way galaxy using Rubin/LSST"	
2023	<b>NRC Herzberg Astronomy and Astrophysics</b> , March 1	Victoria, Canada
	"Building a unified model of the Milky Way galaxy"	
2022	<b>Good Vibrations Seminar</b> , Oct. 26	
	"Multitaper Spectral Analysis: Precise asteroseismic modeling of stars, exoplanets, and beyond" (virtual)	
2022	<b>Astronomical Software Development Workshop</b> , May 20	New York, USA
	"Project Governance & Management" Session Lead (cancelled due to COVID-19)	
2021	<b>Women of Aeronautics and Astronautics (WoAA), India</b> , Dec. 4	
	Around the World Speaker Series: "From Computer Engineering to Astrophysics" (virtual)	
2021	<b>Statistical Challenges in Modern Astronomy VII Conference</b> , June 10	
	Bayesian Breakout: "Likelihood-free Inference of Chemical Homogeneity in Open Clusters" (virtual)	
2020	<b>Joint Conf. for Sch. &amp; Uni. students on Natural &amp; Math. Sciences, Ukraine</b> , Dec. 3	
	"How did the Milky Way Galaxy Form and Evolve?" (virtual)	
2020	<b>International CHASC AstroStatistics Centre, Harvard University</b> , Nov. 17	
	"Likelihood-free Inference of Chemical Homogeneity in Open Clusters" (virtual)	

### Conferences/Seminars

2024	<b>243rd meeting of the American Astronomical Society</b> , Jan. 8	New Orleans, USA
	"Decoding the age-chemical structure of the Milky Way disk: An application of Copulas and Elicitable Maps"	
2023	<b>Astrostatistics in Canada and Beyond</b> , Nov. 2	Banff, Canada
	"Decoding the age-metallicity structure of the Milky Way disk using Copulas & Elicitable Maps"	
2023	<b>Joint Statistical Meetings (JSM) Conference</b> , Aug. 8	Toronto, Canada
	"Improving Power Spectral Estimation using Multitapering: Precise modelling of stars, exoplanets, and beyond"	
2023	<b>TASC7/KASC14 Workshop</b> , July 21	Honolulu, USA
	"Multitaper Spectral Analysis: Precise asteroseismic modeling of stars, exoplanets, and beyond"	
2023	<b>Canadian Astronomical Society (CASCAS) Meeting</b> , June 14	Penticton, Canada
	"Building a unified model of the Milky Way galaxy"	
2023	<b>Wide-Field Spectroscopy vs Galaxy Formation Theory</b> , March 29	Tucson, USA
	"Decoding the age-metallicity structure of the Milky Way disk: An application of Copulas and Elicitable Maps"	
2022	<b>JSM Conference</b> , Aug. 11	D.C., USA
	ASA/AIG Finals: "Functional Data Analysis for Extracting the Intrinsic Dimensionality of Spectra"	
2022	<b>TASC6/KASC13 Workshop</b> , July 11	
	Pitch: "Asteroseismology with Multitaper Methods: Improvements for Stars, Planets & the Milky Way" (virtual)	

- 2022 **Multitaper Spectral Analysis Workshop**, June 26  
 “Asteroseismology with Multitaper Methods” (virtual)
- 2021 **Statistics & Machine Learning (SMILE) Journal Club**, UofT, Nov. 19  
 “Multitaper Spectral Estimation for Asteroseismology” (virtual)
- 2021 **HRMOS Science Workshop**, October 21  
 “Functional Data Analysis for Extracting the Intrinsic Dimensionality of Spectra” (virtual)
- 2021 **Sloan Digital Sky Survey (SDSS) Meeting**, August 11  
 “Functional Data Analysis for Extracting the Intrinsic Dimensionality of Spectra” (virtual)
- 2021 **JSM Conference**, August 10  
 “Modeling the Chemical Structure of Stars: Functional Data Analysis & Bayesian Inference” (virtual)
- 2021 **GALactic Archaeology with HERMES Science Meeting**, June 24  
 “Functional Data Analysis for extracting the Intrinsic Dimensionality of Spectra” (virtual)
- 2021 **SCMA VII Conference**, June 7  
 Poster: “Functional Data Analysis for extracting the Intrinsic Dimensionality of Spectra” (virtual)
- 2021 **Stellar Stats Workshop**, UofT, May 28  
 “Functional Principal Component Analysis (FPCA) in Stellar Spectroscopy” (virtual)
- 2020 **SMILE**, UofT, October 16  
 “Introduction to Neural Networks” (virtual)
- 2020 **JSM Conference**, August 4, **SDSS Meeting**, June 24  
 “Likelihood-free Inference of Chemical Homogeneity in Open Clusters” (virtual)
- 2019 **Canadian Astronomical Society (CASA) Conference**, June 17 Montreal, Canada  
 Poster: “CHIME/Pulsar Evolution of PSR B1508+55: Potential Echoes from the Interstellar Medium”
- 2018 **Global Radio Scintillometry Astrophysics Conference**, October 20 Shanghai, China  
 Poster: “CHIME Monitoring of Pulsars & the Interstellar Medium towards them”
- 2018 **Python in Astronomy Conference**, April 30 New York, USA  
 “GSoC 2017 with Astropy”

## MENTORING AND TEACHING

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### Graduate Student Mentor

- 2024 - Present **Jenny Su** (Astronomy & Astrophysics, UofT) with Gwendolyn Eadie (UofT)  
 AST 1501 project: “Estimating the periodicities of RR Lyrae stars using the multitaper F-test”
- 2022 - Present **Jiayi Sun** (Computer Eng., UofT) with Shurui Zhou (UofT) and Jin Guo (McGill)  
 PhD project: “Improving collaboration efficiency of open-source scientific software teams”
- 2021 **Suyog Garg** (Physics, University of Tokyo) with Hans Moritz Guenther (MIT)  
 GSoC project: “Implementing the MRT/CDS table standards in Astropy”

### Instructor

- 2023 **The Astropy training school** Sofia, Bulgaria  
 Co-designed & taught a week-long (40 hrs) intensive Astropy course for students/scientists from Eastern Europe
- 2022 **Pan-African School for Emerging Astronomers (PASEA)** Livingstone, Zambia  
 Co-designed & taught a week-long (40 hrs) intensive Python/Astropy course for postgraduate students from Africa
- 2022 **PASEA Alumni Research Program (Virtual)**  
 Co-designed & taught a Python online course on Astronomical Data Analysis to PASEA alumni

### Teaching Assistant (TA)

- 2021, 2022 **Head TA**, AST 201: The Sun and its Neighbours, UofT
- 2020, 2021 **TA**, AST 221: Stars and Planets, UofT
- 2019, 2020 **TA**, AST 201: The Sun and its Neighbours, UofT

2018, 2019 **TA**, AST 101: Stars and Galaxies, UofT

## Workshops

2024 **Introduction to Statistics 101**

MPIA, Germany

Designed and taught a hands-on statistics workshop over 6 hours

## Training & Certification

2021 - 2022 Teaching Fundamentals Certificate, Teaching Assistants' Training Program, UofT

2020 Advanced Training in Academic Writing and Speaking, GCAC, UofT

## ACTIVE SCIENTIFIC COLLABORATIONS

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2024 **Euclid consortium**: Member working on some of the first images/spectra

2023 **LSST Discovery Alliance**: One of the Rubin community ambassadors as a catalyst fellow

2020 **Kepler Asteroseismic Science Consortium**: Member working on Kepler time-series analysis

2019 **Sloan Digital Sky Survey-IV**: Member working on APOGEE spectral analysis

2017 **The Astropy Collaboration**: Core team member developing software and managing finances

## SOFTWARE SKILLS

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### Programming Languages

Advanced Python, C/ C++, Shell Script

Intermediate R, Java, JavaScript

### Open-Source Packages

Lead [tapify](#)

Contributor [astropy](#) (#33), [sewpy](#) (major), [numpy](#) (minor)

Example Codes [specdims](#), [mtls](#), [X0dia](#), [Assembly](#)

Competitive Coding [CodeChef](#)

Frameworks/Tools Git, Emacs, TensorFlow/PyTorch/Keras, CUDA, MATLAB, Raspberry Pi

## SELECTED PROFESSIONAL ACTIVITIES & SERVICES

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### Workshops & Schools

2023 **Scientific Organizing Committee Member**, [Python/AstroPy](#) training school

2022 - Present **Organizer, Postgraduate Stream Instructor**, [PASEA](#), Africa

2022 **Scientific Organizing Committee Member**, [Gaia Hike](#) Workshop

Co-developed the talk/tutorial schedule and led the unconference session programming

### Organizations

2021 - Present **Finance Committee Member, Voting Member**, The Astropy Project

Helped raise/manage ~1.6 million USD for the project, Ranked 32nd in code contributions

2021 - Present **International Member**, WoAA, India

Supporting women, gender minorities, LGBTQI+ people in aeronautics, astronautics, STEM

### University of Toronto

2022 - Present **Organizing Committee Member**, SMILE Journal Club

Inviting local/external speakers in astrostatistics and astroinformatics; organizing talks

2021 - Present	<b>Learn Astropy Project Local Representative</b> , Dunlap Institute Improving the computing skills of the Institute and developing educational resources for Astropy
2021 - 2022	<b>Anti-Racism Meetings Organizing Member</b> , DADDAA Running weekly meetings to learn and to take action against racism in the workplace
2021 - 2022	<b>Undergraduate/Graduate Mentor</b> (Student Life), Astronomy & Astrophysics
2020 - Present	<b>Governing Board Risk Committee Member</b> , Massey College First Elected Student on the Governing Board; helped develop the COVID-19 risk plan
2019 - Present	<b>MasseyScope Committee Co-founder</b> , Massey College Organizing astronomy outreach with a focus on underprivileged communities
2018 - 2020	<b>Anti-Racism and Diversity Committee Co-chair</b> , Massey College
2019 - 2020	<b>Lionel Massey Fund Co-chair, Treasurer</b> (Student Life), Massey College
2018 - 2021	<b>Mental Health, Health &amp; Safety, Course Committee Member</b> , Grad. Astronomy

## OTHER OUTREACH

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2018 - 2022	AstroTours Toronto Outreach Volunteer
2018 - 2020	Astronomy on Tap Toronto Volunteer
2020	National Society of Black Physicists Booth Volunteer
2019	Planet Party Toronto Volunteer
2019	Science Rendezvous Toronto Volunteer

## MEDIA

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2021	<b>Massey Dialogues:</b> “The Stars are Aligned, the Future of Astrophysics”, UofT A publicly-streamed conversation with <a href="#">CITA Director</a> Juna Kollmeier and Martine Lokken
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## LANGUAGES

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<b>English</b>	Near-native reading, speaking, oral comprehension, and writing
<b>German</b>	Intermediate reading; beginner speaking, oral comprehension, and writing
<b>Hindi</b>	Native Speaker
<b>Marathi</b>	Native Speaker