Aarya Patil

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Research Interests

My research spans a wide range of data-rich problems on the formation and evolution of disk galaxies. I develop novel statistical and computational methods to study stellar populations in the Milky Way (MW) using a combination of spectroscopic, asteroseismic, and astrometric data.

Education

2018 - 2023 **University of Toronto**, Direct-Entry PhD in Astronomy & Astrophysics — Canada
Thesis: Decoding the age-metallicity structure of the MW disk (to be completed by August 2023)
Supervisors: Jo Bovy & Gwendolyn Eadie

2014 - 2018 **S. P. Pune University**, BEng in Computer Engineering (CGPA: 9.45/10) — India

Major Fellowships & Awards

2022 - 2025 **Data Sciences Institute Doctoral Student Fellowship** — CAD 75,000
Data Sciences Institute, University of Toronto (UofT)

2022 **Best Astrostatistics Student Paper Finalist Award** — USD 100
American Statistical Association/Astrostatistics Interest Group (ASA/AIG)

2021 - 2022 **International Graduate Student Doctoral Fellowship** — CAD 3,000
D. A. D. Dept. of Astronomy & Astrophysics (DADDAA), UofT

2021 **Delta Kappa Gamma World Fellowship Runner-up**
International World Fellowship Committee, Delta Kappa Gamma

2018 - 2022 **C.A. Chant Fellowship in Astronomy** — CAD 45,000
DADDAA, UofT

2018 - 2022 **University of Toronto Fellowships** — CAD 27,456
Faculty of Arts & Science, UofT

2018 - 2021 **Massey College Junior Fellowship** — CAD 10,950
Massey College, UofT

2017 **ABU ROBOCON 2017 - All India Rank 10** out of 125 teams
Programming Head, Pune Institute of Computer Technology Robotics Team

Major Grants

2022 **Astropy Cycle III Funding Grant** — USD 11,550
Lead: "Pan-African School for Emerging Astronomers (PASEA) 2022 in Zambia"

2022 **Dunlap Institute (UofT) Seed Funding Grants** — CAD 35,968
Co-Investigator (Co-I): "PASEA 2022 in Zambia" ($29,100)
Co-I: "Intertwining Dunlap/UofT & Sustainable Open-Source Software via Astropy" ($6868)

Employment History

2017 **Student Developer**, Google Summer of Code (GSoC) Participant with OpenAstronomy
Mentors: Tom Aldcroft (Harvard CfA), Marten van Kerkwijk (UofT), Hans Moritz Günther (MIT)
Role: Developed the first open-source implementation of the FITS time coordinate system in Astropy

Publications

Refereed

Refereed (incl. submitted) publications available online at
https://ui.adsabs.harvard.edu/public-libraries/7Ek22n9ERuaEYfrwLQfFCA.

In preparation:

1. **Patil, A. A.**; Bovy, J.; & Jaimungal, S. "Decoding the Age-Metallicity Structure of the Milky Way disk: An application of Copulas and Elicitable Maps". To be submitted to the Monthly Notices of the Royal Astronomical Society in November 2022.

2. Sun, J.*; **Patil, A. A.**; Guo, J.; & Zhou, S. "A Case Study of an Open-Source Scientific Software". To be submitted to the ACM Joint European Software Engineering Conference and Symposium on the Foundations of Software Engineering (ESEC/FSE) in December 2022.

Submitted:

1. **Patil, A. A.**; Eadie, G.; Speagle, J.; & Thomson, D. "Multitaper Spectral Estimation in Astero-seismology". Submitted to The Astronomical Journal, 32 pp. [arXiv/2209.15027]

Published:

1. The Astropy Collaboration, Price-Whelan, A. M.; Lim, P. L.; Earl, N.; Starkman, N.; Bradley, L.; Shupe, D. L.; **Patil, A. A.** et al. (2022). "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] [35 citations]
   Role: I was responsible for writing significant parts of this paper, which highlights some of my recent contributions to the project as a finance committee member, voting member, and core contributor. My work in Astropy as a GSoC 2017 student developer is specifically described in this paper.

2. **Patil, A. A.**; Bovy, J.; Eadie, G.; & Jaimungal, S. (2022). "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] [2 citations]

3. The Astropy Collaboration et al. including **Patil, A. A.** (2018). "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, 19 pp. [arXiv/1801.02634] [4067 citations]
   Role: This paper describes some of my work as a core contributor to the version 2.0 of the Astropy package.

Software:

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

2. Robitaille, T. et al. including **Patil, A. A.** (2021) "astropy/astropy: v4.2.1", Zenodo. https://zenodo.org/record/4670729

Conference Proceedings:

1. **Patil, A.**; Bovy, J.; & Eadie G. (2020). "Likelihood-free Inference of Chemical Homogeneity in Open Clusters". 2020 Joint Statistical Meetings Proceedings, American Statistical Association (ASA), pp 1838-1844.

Presentations

Invited Talks/Discussions

2022 **Astronomical Software Development Workshop**, May 20 New York, USA
"Project Governance & Management" Session Lead (format alterations due to COVID-19)

2021 **Women of Aeronautics and Astronautics (WoAA), India**, Dec. 4
Around the World Speaker Series: "From Computer Engineering to Astrophysics" (virtual)

2021 **Statistical Challenges in Modern Astronomy VII Conference**, June 10
Bayesian Breakout: "Likelihood-free Inference of Chemical Homogeneity in Open Clusters" (virtual)

2020 **Joint Conf. for Sch. & Uni. students on Natural & Math. Sciences, Ukraine**, Dec. 3
"How did the Milky Way Galaxy Form and Evolve?" (virtual)

2020 **International CHASC AstroStatistics Centre, Harvard University**, Nov. 17
"Likelihood-free Inference of Chemical Homogeneity in Open Clusters" (virtual)

Selected Conferences/Seminars

2022 **Good Vibrations Seminar**, October 26
"Multitaper Spectral Analysis: Precise asteroseismic modeling of stars, exoplanets, and beyond" (virtual)

2022 **Joint Statistical Meetings (JSM) Conference**, August 11 D.C., USA
ASA/AIG Finals: "Functional Data Analysis for Extracting the Intrinsic Dimensionality of Spectra"

2022 **TASC6/KASC13 Workshop**, July 11
"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 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 (CASCA) 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"

Education

Graduate Student Mentoring

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 the Astropy Python package"

Teaching Assistantship (TA)

2021, 2022 **Head TA**, AST 201: The Sun and its Neighbours, University of Toronto
Role: Led 30+ TAs for providing course contact and project support

2020, 2021 **TA**, AST 221: Stars and Planets, University of Toronto
Role: Designed and ran weekly tutorials, held office hours, marked exams, answered emails

2019, 2020 **TA**, AST 201: The Sun and its Neighbours, University of Toronto
Role: Ran weekly tutorials, planetarium shows & observing nights, created test questions

2018, 2019 **TA**, AST 101: Stars and Galaxies, University of Toronto
Role: Same as AST 201

Workshops Designed and Facilitated

2022 **Pan-African School for Emerging Astronomers (PASEA)** Livingstone, Zambia
Postgraduate Stream Instructor: designed and taught a week-long Python/Astropy workshop

2022 **PASEA Alumni Research Program (Virtual) 2022**
Developed and taught a Python workshop on Astronomical Data Analysis to PASEA alumni

Selected Professional Activities & Services

Workshops & Schools

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 31st 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 **Learn Astropy Project Local Representative**, Dunlap Institute
Improving the computing skills of the Institute and developing educational resources for Astropy

2021 - 2022 **Anti-Racism Meetings Organizing Member**, DADDAA
Running weekly meetings to learn and to take action against racism in the workplace

2021 - 2022 **Undergraduate/Graduate Mentor** (Student Life), Astronomy & Astrophysics

2020 - Present **Governing Board Risk Committee Member**, Massey College
First Elected Student on the Governing Board; helped develop the COVID-19 risk plan

2019 - Present **MasseyScope Committee Co-founder**, Massey College
Organizing astronomy outreach with a focus on underprivileged communities

2018 - 2020 **Anti-Racism and Diversity Committee Co-chair**, Massey College

2019 - 2020 **Lionel Massey Fund Co-chair, Treasurer** (Student Life), Massey College
2018 - 2021 **Mental Health, Health & Safety, Course Committee Member**, Grad. Astronomy

Other Outreach

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

Skills

Open-Source Software: `tapify` (lead developer), `astropy` (#32 contributor), `numpy` (contributor)
Programming Languages: Python, C/ C++, Shell Script, R, Java, JavaScript, Assembly
Competitive Coding: CodeChef
Frameworks/Tools: Git, Emacs, TensorFlow/PyTorch/Keras, CUDA, MATLAB, Raspberry Pi

Training & Certification

2021 - 2022 Teaching Fundamentals Certificate, Teaching Assistants' Training Program, UofT
2020 Advanced Training in Academic Writing and Speaking, GCAC, UofT

Travel Awards

2022 ASA/AIG Travel Award, Gordon and Betty Moore Foundation
2022 Astronomical Software Development Travel Award, Simons Foundation
2022 Thesis Research Travel Award, University of Toronto
2018 - 2021 Reinhardt Travel Awards, University of Toronto
2019 Python in Astronomy Travel Award, Space Telescope Science Institute
2018 Python in Astronomy Travel Award, Simons Foundation

MEDIA

2021 **Massey Dialogues**: "The Stars are Aligned, the Future of Astrophysics", UofT

Languages

English Near-native reading, speaking, oral comprehension, and writing
German Advanced reading; beginner oral comprehension
Hindi Native Speaker
Marathi Native Speaker