JOSHUA S. SPEAGLE (沈佳士)

Statistical Sciences | Astronomy & Astrophysics
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RESEARCH INTERESTS

I develop methods and analyze large datasets to understand how **galaxies** like our own **Milky Way** form, behave, and evolve. This work lies in the interdisciplinary fields of **astrostatistics** and **data science** at the intersections of statistics, astronomy, and computer science.

POSITIONS

Assistant Professor of Astrostatistics: University of Toronto 2022-Present
Dunlap Postdoctoral Fellow: University of Toronto 2020-2022
Banting Postdoctoral Fellow: University of Toronto 2020-2022
Supervisor: Gwen Eadie
Project Academic Support Staff: Kavli IPMU, University of Tokyo 2015-2016
Supervisors: Naoki Yoshida, Alexie Leauthaud, & Kevin Bundy

EDUCATION

Harvard University: PhD in Astronomy 2016-2020
Advisers: Doug Finkbeiner, Charlie Conroy, Daniel Eisenstein, & Alyssa Goodman
Harvard University: MA in Astronomy 2016-2020
Advisers: Daniel Eisenstein & Alexie Leauthaud
Harvard University: BA in Astrophysics and Physics 2011-2015

SELECTED AWARDS & HONORS

Best Astrostatistics Student Paper Award (ASA/AIG) 2020
Eric R. Keto Prize for Best Thesis in Theoretical Astrophysics (Harvard) 2020
Department of Astronomy Teaching Award (Harvard) Spring 2018
Bok Center Certificate of Distinction in Teaching (Harvard) Spring 2017, 18; Fall 2018
NSF Graduate Research Fellowship (USA) 2016

TEACHING

I have a strong interest in education and pedagogy, with a focus on skills such as programming, statistics, and data science. See my **teaching statement** for additional details.

EQUITY, DIVERSITY, & INCLUSION

I am committed to improving equity, diversity, and inclusion (EDI) in the classroom, in my work, and in the wider academic community. See my **EDI statement** for additional details.

SUPERVISION & MENTORSHIP

I am currently (co-)supervising/mentoring a total of **14 individuals**. See my **List of Mentees** for a full record of the **20 individuals** I have (co-)supervised/mentored.

Graduate

3. Sam Berek (Astronomy, Toronto) Spring 2022-Present
   Modelling Galaxy Globular Clusters Populations with Hurdle Models (with Gwen Eadie)
2. Yunyi Shen (Statistics, Madison → CompSci, MIT) Summer 2021-Present
   Modelling Stellar Flares with HMMs (with Vianey Leos Barajas, Gwen Eadie, Amber Medina)
1. Aarya Patil (Astronomy, Toronto) Winter 2021-Present
   Stellar Asteroseismology with Multitaper Methods (with Gwen Eadie)

Undergraduate

11. Grace Yu (Computer Science, Toronto) Summer 2022-Present
    Mapping the Milky Way with Blue Horizontal Branch Stars (with Ting Li)
10. Jinoo Kim (Astronomy, Toronto) Summer 2022-Present
    Estimating Galaxy Sizes from Panchromatic Images (with Lamiya Mowla and Kartheik Iyer)
9. Robin Wen (Physics, Waterloo → Caltech) Summer 2022-Present
   Hierarchical Modelling of Globular Cluster Properties (with Jeremy Webb and Gwen Eadie)
8. Feiyu Quan (Astronomy, Toronto) Summer 2022-Present
   Investigating Warped Disk Galaxies in IllustrisTNG (with Neige Frankel and J.J. Zanazzi)
7. Charlie Hughes (Astronomy, Toronto) Fall 2021-Present
   Estimating Photometric Metallicities with DECam and S5 (with Ting Li)
6. Daniel Ding (Engineering, Toronto → Amazon) Fall 2021-Present
   Exploring Latent Space Decompositions of APOGEE Spectra (with Jo Bovy)
5. Ava Oveisi (CompSci, Toronto-Scarborough) Summer 2021-Present
   Imaging Cosmic Dust with Machine Learning (with Kristen Menou)
4. Alicia Savelli (Physics, Brock → Astronomy, Toronto) Summer 2021-Present
   Characterizing Milky Way Analogues in Cosmological Simulations (with Ted Mackereth)
3. Jeff Shen (Astronomy, Toronto → Princeton) Winter 2020-Present
   Estimating Stellar Parameters using Gaia DR3 BP/RP Spectra (with Neige Frankel)
   Disentangling Stellar Ages from Galactic Evolution (with Neige Frankel & Ted Mackereth)
   Milky Way Mass Estimates with H3 (with Gwen Eadie, Norm Murray, & Dennis Zaritsky)
2. Mingxuan Teng (CompSci, Toronto) Fall 2020-Present
   Detecting Outliers in Machine Learning Applications (with Renée Hložek)
1. Zhiya Lou (Statistics, Toronto → ICL) Fall 2020-Present
   Bayesian Model Selection with Globular Clusters (with Gwen Eadie and Jeremy Webb)

SELECTED PROFESSIONAL ACTIVITIES & SERVICE

American Astronomical Society (AAS)

Steering Committee: Working Group on Astroinformatics & Astrostatistics 2020-Present

American Statistical Association (ASA)

Web Director: Astrostatistics Interest Group 2020-Present

Canadian Astronomical Society (CASCA)

Postdoc Committee 2020-Present

University of Toronto (UofT) Astronomy

Training & Mentoring Committee 2021-Present

Summer Undergraduate Research Program (SURP) Committee 2021-Present

Graduate Admissions Committee Winter 2021

Co-Founder: Statistics & MachIne Learning (SMILE) Journal Club 2020-Present

Center for Astrophysics | Harvard & Smithsonian (CfA)

Founder: CfA Machine Learning Journal Club 2017-2020

Workshops & Conferences

Joint Statistical Meetings (JSM) 2021 August 2021

Topic-Contributed Panel: Understanding a Data-Rich Universe with Data-Driven Approaches

Co-organizer: Annual UofT Stellar Stats Workshop 2021-Present

Manuscript Referee

Annals of Applied Statistics 2022-Present

Statistical Science 2022-Present

RAS Techniques and Instruments (RASTI) 2022-Present

Bayesian Analysis 2021-Present

Journal of Open Source Software (JOSS) 2020-Present

Astronomy & Astrophysics (A&A) 2017-Present

Monthly Notices of the Royal Astronomical Society (MNRAS) 2016-Present

American Astronomical Society (AAS) Journals (AJ, ApJ, ApJL, ApJS) 2014-Present

SELECTED PRESENTATIONS

Invited Conference Talks

IAUGA 2022: Machine Learning in Astronomy: Possibilities and Pitfalls August 2022

Incorporating Errors into Machine Learning Methods

UCLA (IPAM): Inference in Gravitational Wave Astronomy Workshop November 2021

An Introduction to (Dynamic) Nested Sampling

University of Surrey: Cross-Research Platform for Bayesian Data-fitting Workshop July 2021

Keynote Address: An Introduction to Nested Sampling

Harvard University: CMSA Big Data Conference August 2018

Revealing the Milky Way's Dust-iny

Colloquia & Seminars

CASCA: CANadian Virtual Astronomy Seminar (CANVAS) April 2022

Mapping the Milky Way Near and Far

IAU-IAA: Astrostats and Astroinfo Seminar April 2022

Statistical Challenges in Stellar Parameter Estimation from Theory and Data

Saint Mary's University: Data Analytics Seminar January 2022

An Introduction to (Dynamic) Nested Sampling

University of Toronto: Toronto Data Workshop October 2021

Stars, Galaxies, and Everything In-Between: Galaxy Evolution Near and Far with Large Datasets

Penn State University: Colloquium — September 2021
Mapping the Milky Way with Stars and Dust

University of Chicago: Kavli Institute for Cosmological Physics Seminar — April 2021
Cosmological Cartography with Photometric Redshifts

CANSSI Ontario: Data Science Applied Research and Education Seminar — February 2021
Mapping the Milky Way in the Age of Gaia

University of Florida: Colloquium — September 2020
Enabling Data-Driven Discovery in the Milky Way and Beyond Using Large Astronomical Datasets

Villanova University: Colloquium — October 2019
Exploring the Galaxy Near and Far in the Age of Gaia

Harvard University: Summer Colloquium (joint with Catherine Zucker) — June 2019
Charting Nearby Molecular Clouds with Gaia: A New Map of Our Local Interstellar Medium

University of Cambridge: Data Intensive Science Seminar — April 2019
Mapping the 3-D Distribution of Dust in the Milky Way with Stellar Photometry

UMass Amherst: Data Science Tea — October 2017
Big Data Inference: Using Hierarchical Bayes and Machine Learning to Improve Photometric Redshifts

Kavli IPMU: Astronomy Lunch Seminar — March 2016
Mapping, Visualizing, and Exploiting the Color-Redshift Relation

University of Tsukuba: Theoretical Astrophysics Seminar — August 2013
The Evolution of Star-Forming Galaxies over Cosmic Time

Contributed Conference Talks

McMaster University: 2022 Clusters Workshop — August 2022
Panchromatic Modelling of Co-Eval Stellar Populations

Seeing the Future: A Conference in Honour of Alyssa Goodman — May 2022
Machine Learning in the Era of Astronomically Big Data

AAS 238: Special Session (Statistics Discussant) — June 2021
Unaccounted Uncertainties: The Role of Systematics in Astrophysics

Astro Hack Week 2020 — August 2020
Introduction to Bayesian Inference with Linear Regression

Lorentz Center: Colours of the Universe Workshop — September 2018
Challenges Working with Posterior Distributions (with Alex Malz)

Public Talks & Events

RASC (Toronto Centre): Speaker's Night — October 2021
Mapping the Milky Way in the Age of Gaia

RASC (Ottawa Centre): Monthly Meeting — June 2021
Mapping the Milky Way in the Age of Gaia

GitHub Satellite 2019 — May 2019
Open-source code contributions (*dynesty*) in the analysis of M87* by the EHT collaboration

PUBLICATIONS

I am an author on **75+ papers** that have **5400+** citations (h-index=27). This includes:

10+ papers as (co-)lead author with 1600+ citations (h-index=10)
15+ papers with significant contributions with 1300+ citations (h-index=13)
3 papers led by students with 15+ citations (h-index=2)

Most of my papers can be found online on arxiv and ADS. My ORCID is 0000-0003-2573-9832. See my full **Publications List** for additional details.

Top 5 Most Cited Publications as (Co-)Lead Author

917 cites: **Speagle, J. S.**; Steinhardt, C. L.; Capak, P. L.; & Silverman, J. D., 2014, The Astrophysical Journal Supplement Series, Vol. 214, Iss. 2, id. 15
A Highly Consistent Framework for the Evolution of the Star-Forming 'Main Sequence' from z~0-6
arxiv: 1405.2041

567 cites: **Speagle, J. S.**, 2020, Monthly Notices of the Royal Astronomical Society, Vol. 493, Iss. 3, p. 3132-3158
dynesty: A Dynamic Nested Sampling Package for Estimating Bayesian Posteriors and Evidences
arxiv: 1904.02180

126 cites: **Zucker, C. & Speagle, J. S.**; Schlafly, E. F.; Green, G. M., Finkbeiner, D. P.; Goodman, A. A.; & Alves, J., 2019, The Astrophysical Journal, Vol. 879, Iss. 2, id. 125
A Large Catalog of Accurate Distances to Local Molecular Clouds: The Gaia DR2 Edition
arxiv: 1902.01425

22 cites: **Speagle, J. S.** & Eisenstein, D. J., 2017, Monthly Notices of the Royal Astronomical Society, Vol. 469, Iss. 1, p. 1186-1204
Deriving Photometric Redshifts with Fuzzy Archetypes and Self-Organizing Maps I. Methodology
arxiv: 1510.08073

19 cites: **Speagle, J. S.** et al. [11 additional co-authors], 2019, Monthly Notices of the Royal Astronomical Society, Vol. 490, Iss. 4, p. 5658-5677
Galaxy-Galaxy Lensing in HSC: Validation Tests and the Impact of Heterogeneous Spectroscopic Training Sets
arxiv: 1906.05876

Top 5 Most Cited Publications with Significant Contributions

428 cites: Green, G. M.; Schlafly, E. F.; Zucker, C.; **Speagle, J. S.**; & Finkbeiner, D. P., 2019, The Astrophysical Journal, Vol. 887, Iss. 1, id. 93
A 3D Dust Map Based on Gaia, Pan-STARRS 1 and 2MASS
arxiv: 1905.02734

186 cites: Tanaka, M.; Coupon, J.; Hsieh, B.-C.; Mineo, S., Nishizawa, A. J.; **Speagle, J.**; Furusawa, H.; Miyazaki, S.; & Murayama, H., 2018, Publications of the Astronomical Society of Japan, Vol. 70, Iss. SP1, id. S9
Photometric Redshifts for the Hyper Suprime-Cam Subaru Strategic Program Data Release 1
arxiv: 1704.05988

149 cites: Steinhardt, C. L.; **Speagle, J. S.** et al. [22 additional co-authors], 2014, The Astrophysical Journal Letters, Vol. 791, Iss. 2, id. L25

Star Formation at 4 < z < 6 from the Spitzer Large Area Survey with Hyper-Suprime-Cam (SPLASH)
arxiv: 1407.7030 **Media**: JPL

148 cites: Leja, J.; Carnall, A. C.; Johnson, B. D.; Conroy, C.; & **Speagle, J. S.**, 2019, The Astrophysical Journal, Vol. 876, Iss. 1, id. 3
How to Measure Galaxy Star Formation Histories II: Nonparametric Models
arxiv: 1811.03637

97 cites: Zucker, C.; **Speagle, J. S.**; Schlafly, E. F.; Green, G. M.; Finkbeiner, D. P., Goodman, A.; & Alves, J., 2020, Astronomy & Astrophysics, Vol. 633, id. A51
A Compendium of Distances to Molecular Clouds in the Star Formation Handbook
arxiv: 2001.00591

Top 5 Most Cited Publications as a Contributing Author

596 cites: Aihara, H. et al. [142 additional co-authors including **Speagle, J. S.**], 2018, Publications of the Astronomical Society of Japan, Vol. 70, Iss. SP1, id. S4
The Hyper Suprime-Cam SSP Survey: Overview and Survey Design
arxiv: 1704.05858

410 cites: Aihara, H. et al. [108 additional co-authors including **Speagle, J. S.**], 2018, Publications of the Astronomical Society of Japan, Vol. 70, Iss. SP1, id. S8
First Data Release of the Hyper Suprime-Cam Subaru Strategic Program
arxiv: 1702.08449

355 cites: Hikage, C. et al. [35 additional co-authors including **Speagle, J. S.**], 2019, Publications of the Astronomical Society of Japan, Vol. 71, Iss. 2, id. 43
Cosmology from cosmic shear power spectra with Subaru Hyper Suprime-Cam first-year data
arxiv: 1809.09148 **Media**: PASJ Excellent Paper Award (English)

171 cites: Mandelbaum, R. et al. [30 additional co-authors including **Speagle, J. S.**], 2018, Publications of the Astronomical Society of Japan, Vol. 70, Iss. Sp1, id. S25
The first-year shear catalog of the Subaru Hyper Suprime-Cam SSP Survey
arxiv: 1706.06745

116 cites: Masters, D. C. et al. [19 additional co-authors including **Speagle, J. S.**], 2015, The Astrophysical Journal, Vol. 813, Iss. 1, id. 53
Mapping the Galaxy Color-Redshift Relation: Optimal Photometric Redshift Calibration Strategies for Cosmology Surveys
arxiv: 1509.03318