JOSHUA S. SPEAGLE

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RESEARCH INTERESTS

My research interests lie in the interdisciplinary fields of **astrostatistics** and **data science** at the intersections of statistics, astronomy, and computer science. I develop methods and analyse large datasets to better understand how **galaxies** like our own **Milky Way** form, behave, and evolve.

POSITIONS

Dunlap Postdoctoral Fellow: Dunlap Institute, University of Toronto 2020-2025
Banting Postdoctoral Fellow: Statistical Sciences, University of Toronto 2020-2022
Supervisor: Gwen Eadie (joint with Astronomy & Astrophysics)

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
Banting Postdoctoral Fellowship (Canada) 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.

STUDENTS

I have (co-)supervised or am currently (co-)supervising a total of **5 students**.

Undergraduate

5. Jeff Shen (3rd year, statistics/astronomy/math, Toronto) — Winter 2020-Present
   Co-supervised with Gwen Eadie & Norm Murray (primary supervisors)
4. Mingxuan Teng (4th year, applied math/computer science, Toronto) — Fall 2020-Present
3. Zhiya Lou (4th year, statistics, Toronto) — Fall 2020-Present
   Co-supervised with Gwen Eadie
2. Alan Tu (2nd year, physics, Harvard) — Summer 2020-Present
   Co-supervised with Catherine Zucker (primary supervisor) & Gus Beane
1. Kaustav Das (4th year, physics, IIT Kanpur) — Summer 2019-Fall 2020
   Co-supervised with Catherine Zucker (primary supervisor)
   Currently a graduate student in astronomy at Caltech

PROFESSIONAL ACTIVITIES

Web Director
American Statistical Association: Astrostatistics Interest Group — 2020-present

Steering Committee Member
American Astronomical Society: Working Group on Astroinformatics & Astrostatistics — 2020-present

Session Organizer
JSM 2021: Understanding a Data-Rich Universe with Data-Driven Approaches (topic-contributed panel discussion) — August 2021

Workshop Organizer
University of Toronto: Stellar Stats Workshop — May 2021

Journal Clubs
Co-Founder: Statistics & Machine Learning Journal Club (University of Toronto) — 2020-present
Co-Organizer: astro-ph Coffee (University of Toronto) — 2020-present
Founder: Center for Astrophysics Machine Learning Journal Club (Harvard University) — 2017-2020

Manuscript Referee
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 Journals (AAS) — 2014-present

SELECTED PRESENTATIONS

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

Astro Hack Week 2020: Tutorial Leader August 2020
Introduction to Bayesian Inference with Linear Regression

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

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

GitHub Satellite 2019: Keynote Address Participant May 2019
Invited for open source code contributions (dynesty) in the analysis of the supermassive black hole in M87 by the Even Horizon Telescope collaboration

University of Toronto: Special Seminar April 2019
Photometric Distances Near and Far in the Age of Gaia

Max Planck Institute for Astronomy: Galaxy Coffee April 2019
The Devil's in the Detail's: Photometric Biases in Modern Surveys

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

Harvard: CMSA Big Data Conference August 2018
Revealing the Milky Way's Dust-iny

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

Harvard: CHASC Astrostatistics Seminar September 2017
An Introduction to Dynamic Nested Sampling

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

PUBLICATIONS

I am an author of **47 papers** that have over **3000 citations** (h-index=19). This includes:
10 papers as (co-)first author (in **red**) with over **1000 citations** (h-index=9)
16 papers with substantial contributions (in **blue**) with over **600 citations** (h-index=11)
1 paper led by students (in **orange**) that I have (co-)supervised

Most of my papers can be found online on arxiv and ADS. My ORCID is 0000-0003-2573-9832.

In Preparation

51. **Tu, A. J.**; Zucker, C.; Beane, A.; **Speagle, J. S.**; Goodman, A.; Alves, J.; Faherty, J.; & Burkert, A., to be submitted to **ApJ**
Characterizing the Kinematics of Young Stars in the Radcliffe Wave

50. Zucker, C.; Goodman, A. G.; Alves, J.; Shmuel, B.; Koch, E.; **Speagle, J. S.**; Foley, M.; Finkbeiner, D. P.; Leike, R.; & Enβlin, T., to be submitted to **ApJ**
On the 3D Spatial Topologies of Local Molecular Clouds

49. **Speagle, J. S.** et al. [18 additional co-authors], to be submitted to **ApJ**
Mapping the Milky Way in 5-D with 170 Million Stars at High Galactic Latitudes

48. **Speagle, J. S.** et al. [18 additional co-authors], to be submitted to **ApJ**
Deriving Stellar Properties, Distances, and Reddenings from Photometry and Astrometry with brutus

Under Review

47. Eadie, G.; **Speagle, J. S.**; Cisewski-Kehe, J.; Foreman-Mackey, D.; Huppenkothen, D.; Jones, D. E.; Springford, A.; & Tak, H., submitted to **Nature Reviews Physics**
Recommendations for Bayesian Inference in Astronomy

46. Nelson, E. J. et al. [24 additional co-authors including **Speagle, J. S.**], submitted to **ApJ**
Spatially Resolved Star Formation and Inside-Out Quenching in the TNG50 Simulation and 3D-HST Observations
arxiv: 2101.12212

45. Emami, R.; Hernquist, L.; Alcock, C.; Genel, S.; Bose, S.; Weinberger, R.; Vogelsberger, M.; Shen, X.; **Speagle, J. S.**; Marinacci, F.; Forbes, J. C.; & Torrey, P.., submitted to **ApJ**
Stellar Halo Morphology from TNG50: Twisted and Twisted-Stretched Halos
arxiv: 2012.12284

44. Bonaca, A.; Naidu, R. P.; Conroy, C.; Caldwell, N.; Cargile, P. A.; Han, J.; Johnson, B. D.; Kruijssen, J. M. D.; Myeong, G. C.; **Speagle, J. S.**; Ying, Y.-S.; & Zaritsky, D., submitted to **ApJL**
Orbital Clustering Identifies the Origins of Galactic Stellar Streams
arxiv: 2012.09171

43. Johnson, B. D.; Leja, J.; Conroy, C.; & **Speagle, J. S.**, submitted to **ApJ**
Stellar Population Inference with Prospector
arxiv: 2012.01426

42. Green, G. M.; Tschesche, L.; Rix, H.-W.; Finkbeiner, D. P.; Zucker, C.; Schlafly, E. F.; Rybizki, J.; & **Speagle, J. S.**, submitted to **ApJ**
Data-Driven Stellar Models
arxiv: 2006.16258

2020

41. Desprez, G. et al. [171 additional co-authors including **Speagle, J. S.**], **A&A**
Euclid Preparation. X. The Euclid Photometric-Redshift Challenge
arxiv: 2009.12112

40. Carter, C.; Conroy, C.; Zaritsky, D.; Ting, Y.-S.; Bonaca, A.; Naidu, R. P.; Johnson, B. D.; Cargile, P. A.; Caldwell, N.; & **Speagle, J. S.**, **ApJ**
Ancient Very Metal-Poor Stars Associated with the Galactic Disk in the H3 Survey

39. Zaritsky, D.; Conroy, C.; Naidu, R. P.; Cargile, P. A.; Putman, M.; Besla, G.; Bonaca, A.; Caldwell, N.; Han, J. J.; Johnson, B. D.; **Speagle, J. S.**; & Ting, Y.-S., **ApJL**
Discovery of Magellanic Stellar Debris in the H3 Survey

38. **Das, K. K.**; Zucker, C.; **Speagle, J. S.**; Goodman, A.; Schlafly, E. F.; Green, G. M.; Finkbeiner, D. P.; & Alves, J., **MNRAS**
Constraining the Distance to the North Polar Spur with Gaia DR2
arxiv: 2009.01320

37. Johnson, B. D.; Conroy, C.; Naidu, R. P.; Bonaca, A.; Zaritsky, D.; Ting, Y.-S.; Cargile, P. A.; Han, J. J.; & **Speagle, J. S.**, **ApJ**
A Diffuse Metal-Poor Component of the Sagittarius Stream Revealed by the H3 Survey
arxiv: 2007.14408

36. Cargile, P. A.; Conroy, C.; Johnson, B. D.; Ting, Y.-S.; Bonaca, A.; Dotter, A.; & **Speagle, J. S.**, **ApJ**
MINESweeper: Spectrophotometric Modeling of Stars in the Gaia Era
arxiv: 1907.07690

35. Cabrera-Ziri, I.; **Speagle, J. S.**; Dalessandro, E.; Usher, C.; Bastian, N. J.; Salaris, M.; Martocchia, S.; Kozhurina-Platais, V.; Niederhofer, F.; Lardo, C.; & Larsen, S. S., **MNRAS**
Searching for Globular Cluster Chemical Anomalies on the Main Sequence of a Young Massive Cluster
arxiv: 2004.09636

34. Bonaca, A.; Conroy, C.; Hogg, D. W.; Cargile, P. A.; Caldwell, N.; Naidu, R. P.; Price-Whelan, A. M.; **Speagle, J. S.**; & Johnson, B. D., **ApJL**
High-Resolution Spectroscopy of the GD-1 Stellar Stream Localizes the Perturber Near the Orbital Plane of Sagittarius
arxiv: 2001.07215

33. Leja, J.; **Speagle, J. S.**; Johnson, B. D.; Conroy, C.; van Dokkum, P.; & Franx, M., **ApJ**
A New Census of the 0.2 < z < 3.0 Universe, Part I: The Stellar Mass Function
arxiv: 1910.04168

32. **Portillo, S. K. N. & Speagle, J. S.**; & Finkbeiner, D. P., **AJ**
Photometric Biases in Modern Surveys
arxiv: 1902.02374
Press: AAS

31. **Speagle, J. S.**, **MNRAS**
dynesty: A Dynamic Nested Sampling Package for Estimating Bayesian Posteriors and Evidences
arxiv: 1904.02180

30. Alves, J.; Zucker, C.; Goodman, A. A.; **Speagle, J. S.**; Meingast, S.; Robitaille, T.; Finkbeiner, D. P.; Schlafly, E. F.; & Green, G. M., **Nature**
Discovery of a Galactic-scale gas wave in the Solar Neighborhood
arxiv: 2001.08748
Press: Official Website

29. Zucker, C.; **Speagle, J. S.**; Schlafly, E. F.; Green, G. M.; Finkbeiner, D. P., Goodman, A.; & Alves, J., **A&A**

A Compendium of Distances to Molecular Clouds in the Star Formation Handbook
arxiv: 2001.00591

2019

28. **Speagle, J. S.**, **arxiv**
A Conceptual Introduction to Markov Chain Monte Carlo Methods
arxiv: 1909.12313

27. Green, G. M.; Schlafly, E. F.; Zucker, C.; **Speagle, J. S.**; & Finkbeiner, D. P., **ApJ**
A 3D Dust Map Based on Gaia, Pan-STARRS 1 and 2MASS
arxiv: 1905.02734

26. Huang, S.; Leauthaud, A.; Hearin, A.; Behroozi, P.; Bradshaw, C.; Ardila, F.; **Speagle, J. S.**; Tenenti, A.; Bundy, K.; Greene, J.; Sifón, C.; & Bahcall, N., **MNRAS**
Weak Lensing Reveals a Tight Connection Between Dark Matter Halo Mass and the Distribution of Stellar Mass in Massive Galaxies
arxiv: 1811.01139
Press: CfA Science Update

25. **Speagle, J. S.**; Leauthaud, A.; Huang, S.; Bradshaw, C. P.; Ardila, F.; Capak, P. L.; Eisenstein, D. J.; Masters, D. C.; Mandelbaum, R.; More, S.; Simet, M.; & Sifón, C., **MNRAS**
Galaxy-Galaxy Lensing in HSC: Validation Tests and the Impact of Heterogeneous Spectroscopic Training Sets
arxiv: 1906.05876

24. Namikawa, T. et al. [73 additional co-authors including **Speagle, J. S.**], **ApJ**
Evidence for the Cross-correlation between Cosmic Microwave Background Polarization Lensing from POLARBEAR and the Cosmic Shear from Subaru Hyper Suprime-Cam
arxiv: 1904.02116

23. Forbes, J. C.; Krumholz, M. R.; & **Speagle, J. S.**, **MNRAS**
Towards a Radially-Resolved Semi-Analytic Model for the Evolution of Disc Galaxies Tuned with Machine Learning
arxiv: 1810.12919

22. Cook, B. A.; Conroy, C.; van Dokkum, P.; & **Speagle, J. S.**, **ApJ**
Measuring Star-Formation Histories, Distances, and Metallicities with Pixel Color-Magnitude Diagrams I: Model Definition and Mock Tests
arxiv: 1904.00011

21. Safarzadeh, M.; Berger, E.; Leja, J.; & **Speagle, J. S.**, **ApJL**
Measuring the Delay Time Distribution of Binary Neutron Stars III. Using the Individual Star Formation Histories of Gravitational Wave Event Host Galaxies in the Local Universe
arxiv: 1905.04310
Press: AAS NOVA

20. Hikage, C. et al. [35 additional co-authors including **Speagle, J. S.**], **PASJ**
Cosmology from cosmic shear power spectra with Subaru Hyper Suprime-Cam first-year data
arxiv: 1809.09148

Press: PASJ Excellent Paper Award (English)

19. Leja, J.; Johnson, B. D.; Conroy, C.; van Dokkum, P.; **Speagle, J. S.**; Brammer, G.; Momcheva, I.; Skelton, R.; Whitaker, K. E.; Franx, M; & Nelson, E. J., **ApJ**
An Older, More Quiescent Universe from Panchromatic SED Fitting of the 3D-HST Survey
arxiv: 1812.05608

18. **Zucker, C. & Speagle, J. S.**; Schlafly, E. F.; Green, G. M., Finkbeiner, D. P.; Goodman, A. A.; & Alves, J., **ApJ**
A Large Catalog of Accurate Distances to Local Molecular Clouds: The Gaia DR2 Edition
arxiv: 1902.01425

17. Leja, J.; Carnall, A. C.; Johnson, B. D.; Conroy, C.; & **Speagle, J. S.**, **ApJ**
How to Measure Galaxy Star Formation Histories II: Nonparametric Models
arxiv: 1811.03637

2018

16. Zucker, C.; Schlafly E. F.; **Speagle, J. S.**; Green, G. M.; Portillo, S. K. N.; Finkbeiner, D. P.; & Goodman, A. A., **ApJ**
Mapping Distances Across the Perseus Molecular Cloud Using CO Observations, Stellar Photometry, and Gaia DR2 Parallax Measurements
arxiv: 1803.08931

15. Medezinski, E.; Oguri, M.; Nishizawa, A.; **Speagle, J. S.**; Miyatake, H.; Umetsu, K.; Leauthaud, A.; Murata, R.; Mandelbaum, R.; Sifón, C.; Strauss, M. A.; Huang, S.; Simet, M.; Okabe, N.; Tanaka, M.; & Yutaka, K., **PASJ**
Source Selection for Cluster Weak Lensing Measurements in the Hyper Sprime-Cam Survey
arxiv: 1706.00427

14. Mandelbaum, R. et al. [30 additional co-authors including **Speagle, J. S.**], **PASJ**
The first-year shear catalog of the Subaru Hyper Suprime-Cam SSP Survey
arxiv: 1706.06745

13. Tanaka, M.; Coupon, J.; Hsieh, B.-C.; Mineo, S., Nishizawa, A. J.; **Speagle, J.**; Furusawa, H.; Miyazaki, S.; & Murayama, H., **PASJ**
Photometric Redshifts for the Hyper Suprime-Cam Subaru Strategic Program Data Release 1
arxiv: 1704.05988

12. Aihara, H. et al. [108 additional co-authors including **Speagle, J. S.**], **PASJ**
First Data Release of the Hyper Suprime-Cam Subaru Strategic Program
arxiv: 1702.08449

11. Aihara, H. et al. [142 additional co-authors including **Speagle, J. S.**], **PASJ**
The Hyper Suprime-Cam SSP Survey: Overview and Survey Design
arxiv: 1704.05858

10. Oguri, M. et al. [24 additional co-authors including **Speagle, J. S.**], **PASJ**
An optically-selected cluster catalog at redshift 0.1<z<1.1 from Hyper Suprime-Cam Subaru Strategic Program S16A data
arxiv: 1701.00818

2017

9. **Speagle, J. S.** & Eisenstein, D. J., **MNRAS**
Deriving Photometric Redshifts with Fuzzy Archetypes and Self-Organizing Maps II. Implementation
arxiv: 1510.08080

8. **Speagle, J. S.** & Eisenstein, D. J., **MNRAS**
Deriving Photometric Redshifts with Fuzzy Archetypes and Self-Organizing Maps I. Methodology
arxiv: 1510.08073

2016

7. **Speagle, J. S.**; Capak, P. L.; Eisenstein, D. J.; Masters, D. C.; Steinhardt, C. L., **MNRAS**
Exploring Photometric Redshifts as an Optimization Problem: An Ensemble MCMC and Simulated Annealing-Driven Template-fitting Approach
arxiv: 1508.02484

6. Steinhardt, C. L.; Capak, P. L.; Masters, D. C.; & **Speagle, J. S.**, **ApJ**
The Impossibly Early Galaxy Problem
arxiv: 1506.01377

2015

5. Masters, D. C. et al. [19 additional co-authors including **Speagle, J. S.**], **ApJ**
Mapping the Galaxy Color-Redshift Relation: Optimal Photometric Redshift Calibration Strategies for Cosmology Surveys
arxiv: 1509.03318

2014

4. Steinhardt, C. L. & **Speagle, J. S.**, **ApJ**
A Uniform History for Galaxy Evolution
arxiv: 1409.2883

3. Steinhardt, C. L.; **Speagle, J. S.** et al. [22 additional co-authors], **ApJL**
Star Formation at 4 < z < 6 from the Spitzer Large Area Survey with Hyper-Suprime-Cam (SPLASH)
arxiv: 1407.7030
Press: JPL

2. **Speagle, J. S.**; Steinhardt, C. L.; Capak, P. L.; & Silverman, J. D., **ApJS**
A Highly Consistent Framework for the Evolution of the Star-Forming 'Main Sequence' from z~0-6
arxiv: 1405.2041

2011

1. **Speagle, J. S.**; Kaplan, D. L.; & van Kerkwijk, M. H., **ApJ**
The X-ray Counterpart of the High-B Pulsar J0726-2612
arxiv: 1111.2877