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

Banting & Dunlap Postdoctoral Fellow: University of Toronto — 2020-present
Joint between Statistical Sciences, Astronomy & Astrophysics, & the Dunlap Institute
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

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

Mingxuan Teng (4th year undergraduate, University of Toronto) — Fall 2020-Present

Zhiya Lou (4th year undergraduate, University of Toronto) — Fall 2020-Present
Co-supervised with Gwen Eadie

Alan Tu (2nd year undergraduate, Harvard) — Summer 2020-Present
Co-supervised with Catherine Zucker & Gus Beane

Kaustav Das (4th year undergraduate, IIT Kanpur) — Summer 2019-Fall 2020
Co-supervised with Catherine Zucker

PROFESSIONAL ACTIVITIES

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

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

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 — 2020-present
Astronomy & Astrophysics — 2017-present
Monthly Notices of the Royal Astronomical Society — 2016-present
American Astronomical Society Journals — 2014-present

SELECTED PRESENTATIONS

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 **45 papers** that have over **2900 citations** (h-index=17). This includes:
10 papers as (co-)first author (in **red**) with over **1000 citations** (h-index=7)
15 papers with substantial contributions (in **blue**) with over **600 citations** (h-index=9)

Most of my papers can be found online on arxiv and ADS. My ORCID is 0000-0003-2573-9832.
Projects that have been led by students I have (co-)supervised are highlighted in **orange**.

In Preparation

50. **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

49. 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

48. **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

47. **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

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

Under Review

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

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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

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