

JOSHUA S. SPEAGLE

Statistical Sciences, Astronomy & Astrophysics, Dunlap Institute
University of Toronto

joshspeagle.github.io | j.speagle@utoronto.ca

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 (UCSC), & Kevin Bundy (UCSC)

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 (UCSC)

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.

PROFESSIONAL ACTIVITIES

Web Director	2020-present
<i>Astrostatistics Interest Group (American Statistical Association)</i>	
Steering Committee Member	2020-present
<i>Working Group on Astroinformatics & Astrostatistics (American Astronomical Society)</i>	
Journal Clubs	
<i>Co-Founder: Statistics & Machine Learning Journal Club (University of Toronto)</i>	2020-present
<i>Co-Organizer: astro-ph Coffee (University of Toronto)</i>	2020-present
<i>Founder: Center for Astrophysics Machine Learning Journal Club (Harvard University)</i>	2017-2020
Manuscript Referee	
<i>Journal of Open Source Software</i>	2020-present
<i>Astronomy & Astrophysics</i>	2017-present
<i>Monthly Notices of the Royal Astronomical Society</i>	2016-present
<i>American Astronomical Society Journals</i>	2014-present

SELECTED PRESENTATIONS

University of Florida: Colloquium	September 2020
<i>Enabling Data-Driven Discovery in the Milky Way and Beyond Using Large Astronomical Datasets</i>	
Astro Hack Week 2020: Tutorial Leader	August 2020
<i>Introduction to Bayesian Inference with Linear Regression</i>	
Villanova: Colloquium	October 2019
<i>Exploring the Galaxy Near and Far in the Age of Gaia</i>	
Harvard: Summer Colloquium (joint with Catherine Zucker)	June 2019
<i>Charting Nearby Molecular Clouds with Gaia: A New Map of Our Local Interstellar Medium</i>	
GitHub Satellite 2019: Keynote Address Participant	May 2019
<i>Invited for open source code contributions (dynesty) in the analysis of the supermassive black hole in M87 by the Even Horizon Telescope collaboration</i>	
University of Toronto: Special Seminar	April 2019
<i>Photometric Distances Near and Far in the Age of Gaia</i>	
Max Planck Institute for Astronomy: Galaxy Coffee	April 2019
<i>The Devil's in the Detail's: Photometric Biases in Modern Surveys</i>	
Cambridge: Data Intensive Science Seminar	April 2019
<i>Mapping the 3-D Distribution of Dust in the Milky Way with Stellar Photometry</i>	
Harvard: CMSA Big Data Conference	August 2018
<i>Revealing the Milky Way's Dust-iness</i>	
UMass Amherst: Data Science Tea	October 2017
<i>Big Data Inference: Combining Hierarchical Bayes and Machine Learning to Improve Photometric Redshifts</i>	
Harvard: CHASC Astrostatistics Seminar	September 2017
<i>An Introduction to Dynamic Nested Sampling</i>	

PUBLICATIONS

I am an author of **48 papers** that have over **2600 citations** ([h-index=17](#)). This includes:

10 papers as (co-)first author (in **red**) with over **900 citations** ([h-index=7](#))

15 papers with substantial contributions (in **blue**) with over **400 citations** ([h-index=9](#))

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

In Preparation

- 48. Zucker, C.; Goodman, A. G.; Alves, J.; Shmuel, B.; Koch, E.; **Speagle, J. S.**; Foley, M.; & Finkbeiner, D. P.
On the 3D Spatial Topologies of Local Molecular Clouds
- 47. **Speagle, J. S.** et al. [18 additional co-authors], submitted to **ApJ**
Mapping the Milky Way in 5-D with 170 Million Stars at High Galactic Latitudes
- 46. **Speagle, J. S.** et al. [18 additional co-authors], submitted to **ApJ**
Deriving Stellar Properties, Distances, and Reddenings from Photometry and Astrometry with brutus

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
- 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
- 43. Johnson, B. D.; Leja, J.; Conroy, C.; & **Speagle, J. S.**, submitted to **ApJ**
Stellar Population Inference with Prospector
- 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](https://arxiv.org/abs/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](https://arxiv.org/abs/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](https://arxiv.org/abs/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](https://arxiv.org/abs/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](https://arxiv.org/abs/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](https://arxiv.org/abs/1910.04168)
32. **Portillo, S. K. N. & Speagle, J. S.**; & Finkbeiner, D. P., **AJ**
Photometric Biases in Modern Surveys
arxiv: [1902.02374](https://arxiv.org/abs/1902.02374)
Press: [AAS](https://www.aas.org/)
31. **Speagle, J. S.**, **MNRAS**
dynesty: A Dynamic Nested Sampling Package for Estimating Bayesian Posteriors and Evidences
arxiv: [1904.02180](https://arxiv.org/abs/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](https://arxiv.org/abs/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](https://arxiv.org/abs/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](https://arxiv.org/abs/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](https://arxiv.org/abs/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](https://arxiv.org/abs/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](https://arxiv.org/abs/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 Suprime-Cam Survey
arxiv: [1706.00427](https://arxiv.org/abs/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](https://arxiv.org/abs/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](https://arxiv.org/abs/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](https://arxiv.org/abs/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](https://arxiv.org/abs/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 $z \sim 0-6$
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](#)