Nathaniel Starkman

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Publications 0000-0003-3954-3291

Education

2024 - 2029 **Massachusetts Institute of Technology**, Postdoctoral Associate — USA
Brinson Prize Fellow 2024-2027

2018 - 2024 **University of Toronto**, PhD in Astronomy & Astrophysics — Canada
NSERC CGS-M Fellow 2019-2020
NSERC CGS-D Fellow 2020-2023
Thesis: Charting Stellar Streams of the Milky Way
Supervisors: Profs. Jo Bovy & Jeremy Webb

2014 - 2018 **Case Western Reserve University**, — USA
B.S. in Mathematical Physics and Astronomy (Summa Cum Laude, GPA 4.0)
Supervisor: Prof. Stacy McGaugh

Major Fellowships & Awards

Feb 2024 **Brinson Prize Fellowship** — USD 360,000
"to support early-career astrophysicists and cosmologists who are committed to chasing bold ideas with creative, nimble, and innovative research."

Feb 2024 **NSERC PDF** — CAD 90,000
Postdoctoral Fellowships program (Natural Sciences and Engineering Research Council of Canada). Declined.

May 2022 **OSOTF HUDD Award at Massey** — CAD 5,000
Ontario Student Opportunity Trust Fund

May 2022 **Jackman Massey Bursary** — CAD 2,900

2020 - 2023 **NSERC - CGS D** — CAD 105,000
Alexander Graham Bell Canada Graduate Scholarship-Doctoral Award (Natural Sciences and Engineering Research Council of Canada)

2019 - 2020 **NSERC - CGS M** — CAD 17,500
Canada Graduate Scholarships 1st Year Program (Natural Sciences and Engineering Research Council of Canada)

2018 - 2024 **University of Toronto Graduate Fellowship** (per annum) — CAD 23-32,000

2018 **Graduate Admissions Award** — CAD 5,000
UofT Faculty of Arts & Science

2014 - 2018 **Case Western Reserve University Merit Scholarship** — USD 120,000

May 2018 **Summa Cum Laude**

May 2018 **Donald A. Glaser Award**
To an outstanding Mathematics and Physics Senior

May 2018 **John Schoff Millis Award**

To the senior with the best academic record in the College of Arts and Sciences

2014-2018 **Dean's High Honor List**
To the students with the best academic record. Awarded semesterly

April 2017 **The Albert A. Michelson Prize**
"To a [3rd year] physics major who has demonstrated superior performance"

April 2017 **Outstanding Junior Award of Arts and Sciences**

March 2017 **Goldwater Scholarship Honorable Mention**
"For exceptional promise of becoming this nation's next generation of research leaders"

April 2016 **Phi Beta Kappa Academic Award**

March 2016 **Goldwater Scholarship Honorable Mention**

Major Grants

2022 **Astropy Cycle III Funding Grant** USD 12,000
NASA ROSES and Moore Foundation funding to Astropy
Lead: "Cosmology in Astropy"

2022 **Astropy Cycle III Funding Grants** USD 8,000
NASA ROSES and Moore Foundation funding to Astropy
Lead: "Quantity 2.0: unitful calculations beyond NumPy"

Professional Positions

2021 - **Astropy Core Developer**
Role: Member, Core Developer Team; lead maintainer for Cosmology, co-maintainer of Units
Funding: See Major Grants.
Team Awards: *2025 AAS Lancelot M. Berkeley-New York Community Trust Prize*

2017 **SOURCE** Participant at Case Western Reserve University (CWRU)
Mentor: Stacy McGaugh (CWRU Astronomy)
Role: Summer research position
Funding: Support of Undergraduate Research and Creative Endeavors (SOURCE)
Project: Developed an algorithm to create maximal disk decompositions of galactic rotation curves. Applied algorithm to SPARC database, extracting lower-bounds on the dark matter content of the sample galaxies. Published in Starkman et al 2018.

2016 **NSF-REU @ CLASSE** Participant at Cornell
Mentor: Ira Wasserman (Cornell Astronomy)
Role: Summer research position at the Cornell Laboratory For Accelerator-Based Sciences And Education (CLASSE)
Funding: National Science Foundation Research Education for Undergraduates (NSF-REU)
Project: Investigated the ability of monopolar neutron star magnetospheres to produce coherent curvature radiation. Coherent radiation near the light cylinder boundary is a potential source for FRB-like signals.

2015 **Summer Research** at Case Western Reserve University (CWRU)
Advisor: John Ruhl (Case Western Reserve University)
Funding: Federal grants awarded to Prof. Ruhl
Project: Built Markov Chain Monte Carlo programs to predict how well South Pole Telescope detectors can distinguish B-modes from noise.

Publications

Click to view the journal article; to view the paper with fully reproducible results, figures, and analysis; for open-source code developed with the paper; for user-facing documentation for the methodologies in the paper; and for open-source datasets released with the publication.

Refereed Papers

Accepted:

1. J. Nibauer, ..., **N.Starkman**, and K. Johnston. *StreamSculptor: Hamiltonian Perturbation Theory for Stellar Streams in Flexible Potentials with Differentiable Simulations.* Submitted to The Astrophysical Journal, arXiv:2410.21174.

Published:

2. **N. Starkman** & Jacob Nibauer, Jo Bovy, Jeremy Webb, Kiyan Tavangar, Adrian Price-Whelan, Ana Bonaca. *Stream Members Only: Data-Driven Characterization of Stellar Streams with Mixture Density Networks.* The Astrophysical Journal (2025), 10.3847/1538-4357/ad94f2.

3. **N. Starkman**, Arthur Kosowsky, Glenn Starkman. *Angular Correlations of Cosmic Microwave Background Spectrum Distortions from Photon Diffusion.* Monthly Notices of the Royal Astronomical Society (2024) 10.1093/mnras/stae665.

4. **N. Starkman**, Jo Bovy, Jeremy Webb, Daniela Calvetti, and Erkki Somersalo. *Characterizing Stream Tracks and Comparing to Simulation.* Monthly Notices of the Royal Astronomical Society (2022), 10.1093/mnras/stad1166.

5. The Astropy Collaboration, Price-Whelan, A. M.; Lim, P. L.; Earl, N.; **Starkman, N.**; 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. [2200 citations]
   Role: Co-wrote the *Highlighted Feature Development*, the *New and Planned Features*, the *Precision, Accuracy, & Reproducibility*, and the *Performance* paper sections.

6. **N. Starkman**, Jagjit Singh Sidhu, Harrison Winch, and Glenn Starkman. *Straight Lightning as a Signature of Macroscopic Dark Matter.* Physical Review D (2020), 10.1103/PhysRevD.103.063024.

7. **N. Starkman**, J. Bovy, and J. Webb. *An extended Pal 5 stream in Gaia DR2.* Monthly Notices of the Royal Astronomical Society (2020), 10.1093/mnras/staa534.

8. P. Li, F. Lelli, S. S. McGaugh, **N. Starkman**, and J. M. Schombert. *A constant characteristic volume density of dark matter haloes from SPARC rotation curve fits.* Monthly Notices of the Royal Astronomical Society (2018). 10.1093/mnras/sty2968.

9. **N. Starkman**, F. Lelli, S. S. McGaugh, and J. Schombert. *A new algorithm to quantify maximum discs in galaxies.* Monthly Notices of the Royal Astronomical Society (2018), 10.1093/mnras/sty2011.

Software Papers

1. GalacticDynamics, **Nathaniel Starkman**, et al.. (2024). GalacticDynamics/unxt: v1.0.0 - JOSS, submitted 10.5281/zenodo.10850455

Select Software Developed

Full enumeration at Zenodo:

1. **Nathaniel Starkman**, Adrian Price-Whelan, & Jacob Nibauer. (2024). GalacticDynamics/galax: v0.0.2 (v0.0.2). Zenodo. 10.5281/zenodo.11553485
2. GalacticDynamics, **Nathaniel Starkman**, et al. (2024). GalacticDynamics/coordinax: v0.3 (v0.3). Zenodo. 10.5281/zenodo.10850557
3. Thomas Robitaille, P. L. Lim, & **Nathaniel Starkman**. (2023). astropy/astropy-iers-data: v0.2023.09.18.00.29.41 (v0.2023.09.18.00.29.41). Zenodo. doi.org/10.5281/zenodo.8353793
4. **Starkman, Nathaniel** & Tessore, Nicolas. (2023). cosmology-api/cosmology.api (v0.1). Zenodo. doi.org/10.5281/zenodo.8331505
5. Thomas Robitaille, Erik Tollerud, ... **Nathaniel Starkman**, et al (2023). astropy/astropy: v5.3.3 Release Notes (v5.3.3). Zenodo. doi.org/10.5281/zenodo.8325470
   Role: core maintainer of the Astropy package
6. **Nathaniel Starkman**. (2023). nstarman/interpolated-coordinates: v0.1 (v0.1). Zenodo. doi.org/10.5281/zenodo.7567111.
7. SkyPy Collaboration, Adam Amara, Lucia F. de la Bella, ..., **Nathaniel Starkman**, et al. (2023). SkyPy (v0.5.2). Zenodo. doi.org/10.5281/zenodo.8132440.
8. Brett M. Morris, Karl, Brigitta Sipőcz, ..., **Starkman, Nathaniel**, et al. (2023). astropy/astroplan: v0.9.1 (v0.9.1). Zenodo. doi.org/10.5281/zenodo.8364087
9. Adrian Price-Whelan, Brigitta Sipőcz, Tom Wagg, **Nathaniel Starkman**, et al. (2022). adrn/gala: v1.6.1. Zenodo. doi.org/10.5281/zenodo.7299506

Other

1. Michael Blanton, et al. (incl. **N. Starkman**) *The Future of Astronomical Data Infrastructure: Meeting Report*, 2023 (arXiv:2311.04272).

Presentations

Invited Talks/Discussions

March 2025	**DARK seminar** (Copenhagen) Bayesian models for detecting streams in LSST data.
October 2024	**CWRU Seminar ()** Stream Members Only: Data-Driven Characterization of Stellar Streams for Inference on the Galactic Potential
January 2023	**CITA Seminar** Astropy Cosmology: the Present and the Expanding Future
March 2022	**Oxford Physics Colloquium** Straight Lightning as a Signature of Macroscopic Dark Matter (Invited Colloquium Talk)
October 2021	**Origins Science Scholars Lecture Series** Science of Origins: Dark Matter and the Milky Way
August 2020	**Johns Hopkins University Physics Journal Club** Straight Lightning as a Signature of Macroscopic Dark Matter
2017	**Cosmology Overview at CWRU Origins** (Talk) The Universe: A Brief History

Selected Conferences/Seminars

August 2024 — **Streams 24: The theory edition** (🔗) (Talk)
From *JAX* to *Galax*, a new generation of stellar stream tools.
Using ML to select stellar stream members.

May 2024 — **ASA: Astrostatistics Interest Group Paper Competition** (🔗) (Talk)
Stream Members Only: Data-Driven Characterization of Stellar Streams.

August 2024 — **ASA: Astrostatistics Interest Group Paper Competition** (🔗) (Talk)
Stream Members Only: Data-Driven Characterization of Stellar Streams.

May 2024 — **Globular Clusters and Their Tidal Tails** (🔗) (Talk)
Stream Members Only: Data-Driven Characterization of Stellar Streams.

May 2024 — **Division on Dynamical Astronomy #55** (🔗) (Talk)
Stream Members Only: Data-Driven Characterization of Stellar Streams.

October 2023 — **DESC sprint week**

March 2023 — **IAUS379: Dynamical Masses of Local Group Galaxies** (🔗) (Poster)
Stellar Stream Track Reconstruction, with Errors (🗄)

May 2023 — **Astropy Conference** (Talk)
An Interoperable Future with Astropy

January 2023 — **AAS 2023** (Talk)
Astropy Tutorials on Units & Constants

October 2022 — **CATS-2022**
Streams22: A workshop for assembling a Community Atlas of Tidal Streams (🔗)

June 2021 — **AAS 2021** (Talk)
Astropy Tutorials on Units & Constants, Coordinates, and Cosmology

May 2021 — **Stellar Stats Workshop** (Talk)
Stellar Stream Track Reconstruction, with Errors

May 2021 — **CASCA AGM** (Poster)
Stellar Stream Track Reconstruction, with Errors

May 2021 — **CASCA AGM** (Poster)
Straight Lightning as a Signature of Macroscopic Dark Matter

August 2020 — **STScI 2020 The Local Group: Assembly and Evolution Symposium** (Poster)
Constraints on Milky Way Halo Triaxiality from Palomar 5

July 2020 — **Kaplan cosmology course** (Talk)
Paid lecturer in Kaplan Cosmology course at Case Western Reserve University

December 2019 — **30th Texas Symposium On Relativistic Astrophysics** (Talk)
Resolving the Recombination Visibility Function Width Tension
Awarded best graduate student presentation.

September 2019 — **5th Gaia Challenge Conference** (Talk)
Extending the Pal5 Stream Detection Limits

September 2019 — **5th Gaia Challenge Conference** (Talk)
Using Manifold Learning Techniques to Identify Stream Progenitors

August 2019 — **Great Lakes Cosmology Workshop** (Talk)
Parameterizing the recombination visibility function

June 2018 — **The Standard Model at 50 Years**
A Celebratory Symposium for the Standard Model (🔗)
Conference Volunteer

June 2017 **Dwarf Galaxies on the Shoulders of Giants**
Workshop on topics related to dwarf galaxies and the dark matter problem
Conference Volunteer

May 2018 **CWRU SOURCE Intersections** (Poster)
A new algorithm to quantify maximal disks

October 2017 **CWRU Physics Seminar** (Talk)
Understanding the Dark Matter distribution in galaxies using maximal disks

August 2017 **CWRU Astronomy Summer Seminar** (Talk)
Understanding the Dark Matter distribution in galaxies using maximal disks

August 2016 **Cornell CLASSE Summer Seminar** (Talk)
Coherent curvature radiation in a neutron star's monopolar magnetic field

Mentoring and Teaching

Student Mentoring

2025 - **Jason Zhang** (MIT) with Prof. Lina Necib (MIT)

2024 - **Charlotte Myers** (MIT) with Prof. Lina Necib (MIT)

2023-25 **Connor McKeigan** (Astronomy, UofT) with Prof. Ting Li (UofT)
Undergraduate thesis project: "Characterizing the stellar streams of S5"

2019,'20,'22 **Massey Tutoring Program**
Volunteer math and physics tutor to prospective first-generation college students

Teaching Assistantship (TA)

2019,'21-24 **TA**, AST 201: Stars and Galaxies — UofT
Role: Designed and ran weekly course tutorial sections, created exam questions, proctored exams, and graded course projects.

2018,'21-23 **TA**, AST 101: The Sun and its Neighbours — UofT
Role: Designed and ran weekly course tutorial sections, planetarium shows, & observing nights; created exam questions, proctored exams, and graded course projects

2019-20 **Lead Observer**: AST101-325 — UofT
Role: Trained and liased with TAs and students in all courses using the campus telescope facilities

2015 **Grader**: Honors Mechanics — CWRU
Graded assignments and exams

2014-15 **Physics Instructor** for IB Physics, Montessori High School — Cleveland
Prepared and tutored IB physics class, assigning and grading homework, for IB exam

Software Skills

Find me on GitHub

Programming Languages	Python, Mathematica (Advanced), Bash, C / C++, CSS, Fortran, HTML, R (Intermediate)
Open-Source Packages	lead: `astropy`, (#12) `cosmology-api`, `interpolated-coordiantes`; contributor: `array-api`, `daft`, `galpy`, `gala`, `gaia_tools`, `skypy`.
Frameworks/Tools	Git, PyTorch/Jax, CUDA, MATLAB

Selected Professional Activities & Services

Conferences & Workshops Organized

June 2025	**Astropy Coordination Meeting** (🔗) Role: SOC	Santa Cruz, USA
May 2025	**Division of Dynamical Astronomy #56** (🔗) Role: SOC	GIT, USA
January 2025	**Gaia Hackathon** (🔗) Role: LOC	MIT, USA
October 2024	**JAXtronomy Workshop** (🔗) Role: SOC	NYC, USA
July 2021	**ComSciCon GTA 2021** (🔗) Role: Organizing Committee member for the Toronto ComSciCon – a workshop series for graduate students on science communication skills	Online
July 2020	**ComSciCon GTA 2020** (🔗) Role: Organizing Committee member for Toronto's first ComSciCon	Online
April 2020	**Massey Telescope Public Talk Series** Role: Co-host and gave talk on Ojibwe (First Nation) constellations	TO, CA
October 2019	**.Astronomy 11** (🔗) Role: Local Organizing Committee member and lead workshop on scientific plotting.	TO, CA

Conferences & Workshops

May 2024	**From JAX to Galax** Workshop at *Globular Clusters and Their Tidal Tails* (🔗)	TO, CA
June 2024	**Astropy Core Developer Conference**	
February 2023	**The Future of Astrophysical Data Infrastructure** (🔗)	NYC, USA
March 2022	**Astropy Core Developer Conference** (Talk) The future of interoperability with Python's Protocols. Role: Core developer, maintainer for Astropy Cosmology and Units.	Boston, USA
July 2019	**ComSciCon Canada 2019** (🔗) Selected participant at Canada's first national science communication workshop for graduate students	Hamilton, CA

Organizations

2021 - Present **The Astropy Project**
Role: Voting Member and Core Developer (ranked 12th in code contributions).
The common core package for Astronomy in Python.

2022 - 2023 **Massey House Committee**
Junior Fellow governance committee at Massey college.

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

2019 - Present **Massey Junior Fellow**, Massey College
University of Toronto's graduate college for those showing exceptional promise and engagement within academia and the world beyond it.Already

2019 - 2020 **Sigma Nu Alumni Advisory Board**
Role: Member of the Sustainability and Chapter Operations committees

2018 - Present **Canadian Astrophyisics Society** (CASCA)

2015 - 2018 **Sigma Nu Fraternity**
Member in good standing. Served as webmaster (2016-2018) in charge of the fraternity webpage for news, programmed events, and intra-fraternal governance.

2015-2017 **Executive Board Member for Chabad at CWRU**
Organized events on campus: dinners, holidays, charity events, and outreach programs.
Role: General Executive Board Member (2016-2017).
Role: Chief financial officer (2015 -2016)

Other Outreach

2019 - 2022 Massey Telescopes Outreach Coordinator
Organizing committee member for astronomy outreach and appreciation at Massey College

2019 - 2021 AstroTours Telescope Organizer
Organizer for all telescope outreach in Dunlap's public event AstroTours

2019 Planet Party Toronto Volunteer

2018 - 2021 AstroTours Toronto Outreach Volunteer

2018 - 2020 Astronomy on Tap Toronto Volunteer

2018 - 2019 AstroTours Planetarium Presenter
Regular planetarium show designer and presenter for Dunlap's AstroTours public outreach.

Small Grants

September 2023	**Dunlap Student Training Grant** To attend the DESC sprint week
June 2023	**Collaboration Meeting Grant** To visit the Center for Computational Astrophysics and collaborate on the paper Characterizing Stellar Streams by ML.
May 2023	**Astropy Moore Travel Grant** To participate in the 2023 Astropy Coordination meeting
September 2022	**Streams22 Conference Bursary** To attend Streams22: the Community Atlas of Tidal Streams workshop
September 2022	**Dunlap Student Training Grant** To attend Streams22: the Community Atlas of Tidal Streams workshop
December 2019	**STScI Travel Funding** To attend STScI 2020 The Local Group: Assembly and Evolution Symposium
December 2019	**Reinhardt Travel Award** To present at the 30th Texas Symposium on Relativistic Astrophysics
August 2019	**Dunlap Student Travel Grant** To present at the 5th Gaia Challenge Workshop (Value: $2,075)
August 2019	**Reinhardt Travel Award** To present at the Great Lakes Cosmology Workshop
July 2019	**ComSciCon Canada Travel Award** To attend the first Canadian Science Communication Conference, ComSciConCAN

MEDIA

2023 **The New Scientist**
Featured in article on various strategies to detect dark matter, including the method from my paper Starkman et al 2020.

2023 **The JCR: A Massey Podcast** - ChatGPT: Friend or Foe
Panelist for a public podcast interviewing researchers on how generative AI is used in various scientific fields.

2022 **Massey Dialogue**: Science and Aesthetics
Panelist for interdisciplinary salon discussion series

2021 **Massey Dialogue**: Techplomacy with Consul General Rana Sarkar
Panelist and co-organizer for a salon discussion on the Future of regulating Big Tech.

2021 **Smithsonian Feature Article**
Interviewed for feature article about my paper Starkman et al 2020.

Languages

English Native reading, speaking, and writing
Spanish Beginner speaking, oral comprehension, and writing
Hebrew Beginner speaking, oral comprehension, and writing