Nathaniel Starkman

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Publications arXiv Zenodo 0000-0003-3954-3291

Education

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

2014 – 2018 **B.S. in Mathematical Physics and Astronomy**, Case Western Reserve University — Cleveland, OH, USA
Summa Cum Laude.
Supervisors: Stacy McGaugh

Professional Appointments

2024 – 2027 **Postdoctoral Associate**, MIT Kavli Institute for Astrophysics and Space Research — Cambridge, MA, USA
Brinson Prize Fellowship (2024–2027).

2021 – **Coordinator (2025 – 2028), Strategic Planner (2025 – 2026) & Core Developer**, Astropy — Remote
Coordination Committee (executive committee), 2025–2028.
Strategic Planning and Organizing Committee, 2025–2026.
Member, Core Developer Team; lead maintainer for Cosmology, co-maintainer of Units.
Funding: Astropy Cycle III — Cosmology and Quantity 2.0.
Team awards: 2025 AAS Lancelot M. Berkeley–New York Community Trust Prize, the 2023 IOP Publishing Top Cited Paper Award and the 2022 ADASS Prize for an Outstanding Contribution to Astronomical Software.

Grants & Fellowships

Oct 2026 **Pacific Postdoc Program at the University of Washington**,
Pacific Postdoc Program Fellow, University of Washington
A one-month fellowship at the Dark Universe Science Center at the University of Washington in Seattle, funded by the Dark Universe Science Center and the Simons Institute.

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

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

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

2019 – 2024 **Massey Junior Fellow**, Junior Fellow, Massey College
University of Toronto's graduate college for those showing exceptional promise and engagement within academia and the world beyond it.

2018 – 2024 **University of Toronto Graduate Fellowship**, University of Toronto — CAD 23,000–32,000 p.a.

Awards

Jan 2025 **AAS Lancelot M. Berkeley–New York Community Trust Prize**, American Astronomical Society, *to the Astropy Collaboration*
Team award, as a core developer and Coordination Committee member of Astropy.

Nov 2023 **IOP Publishing Top Cited Paper Award, North America**, IOP Publishing
to the Astropy Collaboration
Team award, as an author of the v5.0 paper: top 1% most-cited in Astronomy and Astrophysics.

May 2022 **OSOTF HUDD Award at Massey**, Massey College
Ontario Student Opportunity Trust Fund

2022 **ADASS Prize for an Outstanding Contribution to Astronomical Software**, Astronomical Data Analysis Software and Systems
to the Astropy Project
Team award, as a core developer of Astropy.

Publications

Students I supervised or advised: undergraduate†, graduate‡.

18. **N. Starkman**, J. Nibauer, S. Pearson, S. Wu‡, L. Necib. *When Streams Curve Away: a Test of Dark Matter from Extragalactic Stellar Stream Populations.* SUBMITTED arXiv:2609.40057

17. Euclid Collaboration, **N. Starkman**, J. Nibauer, S. Pearson, S. Wu‡, M. Walmsley, L. Necib, et al. *Euclid Quick Data Release (Q1): The geometry of dark matter halos from extragalactic streams.* Astronomy & Astrophysics SUBMITTED ADS arXiv:2606.21774

16. C. Myers†, **N. Starkman**, L. Necib. *Reconstructing Galactic Gravitational Potentials from Stellar Kinematics with Physics-Informed Neural Networks.* Monthly Notices of the Royal Astronomical Society SUBMITTED ADS arXiv:2606.18386

15. L. Necib, D. Folsom, E. Y. Davies, **N. Starkman**, A. Thoyas. *Galactic Amnesia: The Information Washout of the Milky Way Merger History.* SUBMITTED ADS arXiv:2605.04138

14. **N. Starkman**, J. Nibauer. *phasecurvefit: A High-Performance JAX Framework for Phase-Space Walks with Pluggable Metrics and Strategies.* Journal of Open Source Software SUBMITTED pyOpenSci review

13. S. Wu‡, **N. Starkman**, S. Pearson, J. Nibauer, J. Miro-Carretero, D. Martinez-Delgado. *Potamides: Mapping Dark Matter Halo Shapes from Stellar Stream Tracks in the Local Universe.* The Astrophysical Journal ACCEPTED ADS arXiv:2605.07809

12. S. Wu‡, **N. Starkman**, J. Nibauer, S. Pearson. *Potamides: JAX tools for curvature-based inference from stellar streams.* Journal of Open Source Software 11, 10712 10.21105/joss.10712

11. C. Myers†, **N. Starkman**, L. Necib. *Physics-Informed Neural Networks for Modeling Galactic Gravitational Potentials.* Advances in Neural Information Processing Systems (NeurIPS 2025) OpenReview

10. J. Nibauer, A. Bonaca, D. N. Spergel, A. M. Price-Whelan, J. E. Greene, **N. Starkman**, et al. *StreamSculptor: Hamiltonian Perturbation Theory for Stellar Streams in Flexible Potentials with Differentiable Simulations.* The Astrophysical Journal 983, 68 10.3847/1538-4357/adb8e8 ADS arXiv:2410.21174

9. **N. Starkman**, A. M. Price-Whelan, J. Nibauer. *unxt: A Python package for unit-aware computing with JAX.* Journal of Open Source Software 10, 7771 10.21105/joss.07771

8. **N. Starkman**, J. Nibauer, J. Bovy, J. Webb, K. Tavangar, A. Price-Whelan, et al. *Stream Members Only: Data-Driven Characterization of Stellar Streams with Mixture Density Networks.* The Astrophysical Journal 980, 253 10.3847/1538-4357/ad94f2 ADS arXiv:2311.16960

7. **N. Starkman**, G. Starkman, A. Kosowsky. *Angular Correlations of Cosmic Microwave Background Spectrum Distortions from Photon Diffusion.* Monthly Notices of the Royal Astronomical Society 529, 2274 10.1093/mnras/stae665 arXiv:2310.01578

6. **N. Starkman**, J. Bovy, J. Webb, D. Calvetti, E. Somersalo. *On the fast track: Rapid construction of stellar stream paths.* Monthly Notices of the Royal Astronomical Society 522, 5022 10.1093/mnras/stad1166 arXiv:2212.00949

5. The Astropy Collaboration, A. M. Price-Whelan, P. L. Lim, N. Earl, **N. Starkman**, L. Bradley, D. L. Shupe, et al. *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 935, 167 ADS arXiv:2206.14220

4. **N. Starkman**, J. S. Sidhu, H. Winch, G. Starkman. *Straight Lightning as a Signature of Macroscopic Dark Matter*. Physical Review D 103, 063024 10.1103/PhysRevD.103.063024 arXiv:2006.16272
3. **N. Starkman**, J. Bovy, J. Webb. *An extended Pal 5 stream in Gaia DR2*. Monthly Notices of the Royal Astronomical Society 10.1093/mnras/staa534 arXiv:1909.03048
2. P. Li, F. Lelli, S. S. McGaugh, **N. Starkman**, J. M. Schombert. *A constant characteristic volume density of dark matter haloes from SPARC rotation curve fits*. Monthly Notices of the Royal Astronomical Society 10.1093/mnras/sty2968 arXiv:1811.00553
1. **N. Starkman**, F. Lelli, S. S. McGaugh, J. Schombert. *A new algorithm to quantify maximum discs in galaxies*. Monthly Notices of the Royal Astronomical Society 480, 2292 10.1093/mnras/sty2011 ADS arXiv:1802.09967

Software Development

phasecurvefit 2026
Paths through phase space

potamides 2026
Constrain gravitational potentials from stellar stream curvature

galax
Galactic dynamics in JAX

plum
Multiple dispatch in Python

coordinax
Coordinates in JAX

unxt 2025
Units in JAX

quax
Multiple dispatch in JAX

Astropy 2022
Astronomy in Python

Invited Talks

Aug 2026 **Marche III: Big Bang, Big Stars, Big Computers (Jesi)** — Jesi, Italy
Energy Structures of Extragalactic Stellar Streams Reveal Dark Matter Halos

Jun 2026 **EAS 26-S10 (Lausanne)** — Lausanne, Switzerland
The Geometry of Dark Matter Halos from Extragalactic Streams

Feb 2026 **CWRU Seminar (Cleveland)** — Cleveland, OH, USA
Computationally Unscrambling EGGS (Extra-Galactic Gravity from Streams)

Nov 2025 **TevPA (Valencia)** — Valencia, Spain
The Geometry of Dark Matter Halos from Extragalactic Streams

Oct 2025 **DARK seminar (Copenhagen)** — Copenhagen, Denmark
The Geometry of Dark Matter Halos from Extragalactic Streams

Oct 2025 **Texas A&M Seminar (Texas)** — College Station, TX, USA
The Geometry of Dark Matter Halos from Extragalactic Streams

Sep 2025 **CCA Software seminar (NYC)** — New York, NY, USA
unxt, coordinax, and software development in JAX

Sep 2025 **Princeton Thunch Seminar (Princeton)** — Princeton, NJ, USA
Euclid: The Geometry of Dark Matter Halos from Extragalactic Streams

Mar 2025 **DARK seminar (Copenhagen)** — Copenhagen, Denmark
Bayesian models for detecting streams in LSST data

Oct 2024 **CWRU Seminar** — Cleveland, OH, USA
Stream Members Only: Data-Driven Characterization of Stellar Streams for Inference on the Galactic Potential

Jan 2023 **CITA Seminar** — Toronto, ON, Canada
Astropy Cosmology: the Present and the Expanding Future

Mar 2022 **Oxford Physics Colloquium** — Online
Straight Lightning as a Signature of Macroscopic Dark Matter (Invited Colloquium Talk)

Presentations

Aug 2026 **New Frontiers in Cosmology (Talk)** — A Coruña, Spain
Energy Structures of Extragalactic Stellar Streams Reveal Dark Matter Halos

Jul 2026 **Near Field Cosmology in the Era of Big Data (Talk)** Toronto, ON, Canada
Energy Structures of Extragalactic Stellar Streams Reveal Dark Matter Halos

Jun 2026 **DARK Seminar (Talk)** Copenhagen, Denmark
Energy Structures of Extragalactic Stellar Streams Reveal Dark Matter Halos

Jan 2026 **York Seminar (Talk)** Toronto, ON, Canada
Euclid: The Geometry of Dark Matter Halos from Extragalactic Streams

Nov 2025 **TeVPA (Talk)** Valencia, Spain
Euclid: The Geometry of Dark Matter Halos from Extragalactic Streams

Oct 2025 **IAUS 403 (Talk)** Córdoba, Spain
Euclid: The Geometry of Dark Matter Halos from Extragalactic Streams

Sep 2025 **Cosmology 2025 (Talk)** Portoferraio, Italy
Euclid: The Geometry of Dark Matter Halos from Extragalactic Streams

Sep 2025 **MKI Journal Club (Talk)** Cambridge, MA, USA
Euclid: The Geometry of Dark Matter Halos from Extragalactic Streams

May 2025 **DDA #56** Atlanta, GA, USA
Extra-Galactic Gravity using Streams (EGGS) from Euclid's Zoo(niverse)

May 2025 **Euclid LU-SWG (Talk)** Lausanne, Switzerland
Extra-Galactic Gravity using Streams (EGGS) from Euclid's Zoo(niverse)

Aug 2024 **ASA: Astrostatistics Interest Group Paper Competition** not attended
Stream Members Only: Data-Driven Characterization of Stellar Streams

Aug 2024 **Streams 24: The theory edition (Talk)** Durham, UK
From JAX to Galax, a new generation of stellar stream tools Using ML to select stellar stream members

May 2024 **Division on Dynamical Astronomy #55 (Talk)** Toronto, ON, Canada
Stream Members Only: Data-Driven Characterization of Stellar Streams

May 2024 **Globular Clusters and Their Tidal Tails (Talk)** Toronto, ON, Canada
Stream Members Only: Data-Driven Characterization of Stellar Streams

Oct 2023 **DESC sprint week** Pittsburgh, PA, USA

May 2023 **Astropy Conference (Talk)** Cambridge, MA, USA
An Interoperable Future with Astropy

Mar 2023 **IAUS379: Dynamical Masses of Local Group Galaxies (Poster)** Potsdam, Germany
Stellar Stream Track Reconstruction, with Errors

Jan 2023 **AAS 2023 (Talk)** Seattle, WA, USA
Astropy Tutorials on Units & Constants

Oct 2022 **CATS-2022** Pasadena, CA, USA
Streams22: A workshop for assembling a Community Atlas of Tidal Streams

Conferences

Sep 2026 **Astropy 2026 Conference** Online
Role: Coordination Committee and Strategic Planning Committee; moderated online discussion and helped moderate the AI sessions.

Aug 2026 **Astrophysics and Space Science in Marche III: Big Bang, Big Stars, Big Computers** Jesi, Italy
Role: SOC

Jan 2026 **Gaia Hackathon** Cambridge, MA, USA
Role: LOC

Jun 2025 **Astropy Coordination Meeting** Santa Cruz, CA, USA
Role: SOC

May 2025 **Division of Dynamical Astronomy #56** Atlanta, GA, USA
Role: SOC

Jan 2025 **Gaia Hackathon** Cambridge, MA, USA
Role: LOC

Oct 2024	**JAXtronomy Workshop** 🔗 Role: SOC	New York, NY, USA
Jun 2024	**Astropy Core Developer Conference**	Santa Cruz, CA, USA
May 2024	**From JAX to Galax** 🔗 Workshop at Globular Clusters and Their Tidal Tails	Toronto, ON, Canada
Feb 2023	**The Future of Astrophysical Data Infrastructure** 🔗	Online
Mar 2022	**Astropy Core Developer Conference (Talk)** The future of interoperability with Python's Protocols Role: Core developer, maintainer for Astropy Cosmology and Units	Boston, MA, USA

Mentoring

May 2026 **Reem Hamraz Google Summer of Code for Astropy** 🔗
Hardening Astropy's core stability

2025 – 2026 **Amir Abdul (Howard)**
Baryon Modeling in External Galaxies with Stellar Streams
Leadership Alliance National Symposium, July 23–25, 2025
2025 NSBP-NSHP Joint Annual Conference, November 19–23, 2025
2026 APS Global Physics Summit, March 14–20, 2026

2025 – 2026 **Taisiia Karasova (MIT) with Prof. Lina Necib (MIT)**
Machine Learning Galaxy intrinsic sizes

2024 – 2026 **Charlotte Myers (MIT) with Prof. Lina Necib (MIT)**
Physics-Informed Neural Networks for Modeling Galactic Gravitational Potentials
NeurIPS Paper

2023 – 2025 **Connor McKeigan (Astronomy, UofT) with Prof. Ting Li (UofT)**
Undergraduate thesis project: "Characterizing the stellar streams of S5"

2019 – 2022 **Massey Tutoring Program**
Volunteer math and physics tutor to prospective first-generation college students
2019, 2020 and 2022.

Teaching

2019 – 2020 **Lead Observer: AST101-325**, University of Toronto
Role: Trained and liaised with TAs and students in all courses using the campus telescope facilities.

2019 – 2024 **TA, AST 201: Stars and Galaxies**, University of Toronto
Role: Designed and ran weekly course tutorial sections, created exam questions, proctored exams, and graded course projects.
2019, 2021–2024.

2018 – 2023 **TA, AST 101: The Sun and its Neighbours**, University of Toronto
Role: Designed and ran weekly course tutorial sections, planetarium shows, & observing nights; created exam questions, proctored exams, and graded course projects.
2018, 2021–2023.

Peer Review

- Journals — Astronomy & Astrophysics · The Astrophysical Journal · European Physical Journal C · Monthly Notices of the Royal Astronomical Society · Journal of Open Source Software (commensurability: a Python package for classifying astronomical orbits based on their toroid volume)
- Panels — National Science Foundation project funding panel

Professional Service

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

2019 – 2024 **MasseyScope Committee Member**, Massey College
Organizing astronomy outreach with a focus on underprivileged communities

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

2018 – **Canadian Astronomical Society (CASCA)**, Canadian Astronomical Society

Outreach

Aug 2026 **Public Talk in Jesi, Italy**, Astrophysics and Space Science in Marche III

Oct 2021 **Origins Science Scholars Lecture Series**, Origins Science Scholars program, Case Western Reserve University — Online
Science of Origins: Dark Matter and the Milky Way

2019 – 2021 **AstroTours Telescope Organizer**, Dunlap Institute for Astronomy & Astrophysics, University of Toronto
Organizer for all telescope outreach in Dunlap's public event

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

2019 **Planet Party Toronto Volunteer**, Department of Astronomy and Astrophysics, University of Toronto

2018 – 2020 **Astronomy on Tap Toronto Volunteer**, Department of Astronomy and Astrophysics, University of Toronto

2018 – 2019 **AstroTours Planetarium Presenter**, Dunlap Institute for Astronomy & Astrophysics, University of Toronto
Regular planetarium show designer and presenter for Dunlap's AstroTours public outreach

2018 – 2021 **AstroTours Toronto Outreach Volunteer**, Dunlap Institute for Astronomy & Astrophysics, University of Toronto

Media

Feb 2023 **The New Scientist**, The New Scientist
Featured in article on various strategies to detect dark matter, including the method from my paper

May 2021 **Smithsonian Feature Article**, Smithsonian Feature Article
Interviewed for feature article about my paper