Farnik Nikakhtar

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Education

Ph.D. in Physics & Astronomy — Philadelphia, PA | 2022
University of Pennsylvania

M.A. in Statistics & Data Science — Philadelphia, PA | 2020
The Wharton School, University of Pennsylvania

B.S. in Physics (Major) & Computer Science (Minor) — Tehran, Iran | 2017
Sharif University of Technology

Honors & Awards

YCAA Postdoctoral Fellowship, Yale Center for Astronomy & Astrophysics — 2023–2026
Balzan Fellowship, Centre for Cosmological Studies, University of Oxford — 2022
NSF Graduate Research Fellowship, U.S. National Science Foundation — 2018–2021
GAPSA Research Travel Grant, University of Pennsylvania — 2019
Research Experiences for Undergrads, Institute for Research in Fundamental Sciences — 2015, 2016
Silver Medalist, Astronomy & Astrophysics Olympiad — 2011

Research Experience

Postdoctoral Fellow — New Haven, CT
Yale Center for Astronomy & Astrophysics, Yale University — 2022–

- **YCAA Prize Postdoctoral Fellow**
- Implementing and applying large-scale structure reconstruction algorithms for the Dark Energy Spectroscopic Instrument (DESI) survey.
- Quantifying the out-of-equilibrium characteristics of dwarf galaxies and constraining their gravitational potential through the analysis of both simulated and observed datasets using deep generative models.

Visiting Graduate Researcher — Paris, France
Institut d'astrophysique de Paris (IAP) — May–July 2022

- Developed and validated semi-discrete optimal transport algorithm for reconstructing Baryon Acoustic Oscillations (BAO) from biased tracers.

Guest Reseacher — New York, NY
Center for Computational Astrophysics (CCA) — Apr–July 2021

- Implemented unsupervised machine learning techniques for objective classification of structures in both simulated (FIRE) and observed (Gaia×APOGEE) stars of the solar neighborhood.

Graduate Researcher Philadelphia, PA
Department of Physics & Astronomy, University of Pennsylvania 2018–2022

- **NSF GRFP Fellow**
- Developed physical models and statistical methods for the reconstruction of Baryon Acoustic Oscillations (BAO) from 2-point correlation function measurements in large-scale galaxy surveys.
- Generated a new suite of realistic synthetic stellar surveys using FIRE (Feedback In Realistic Environments) simulations designed to resemble the crossmatch between Gaia and APOGEE observations.

Teaching Experience

Yale Certificate of College Teaching Preparation (CCTP) 2022–
UPenn Certificate in College and University Teaching 2021

Guest Lecturer

Machine Learning in Astronomy New York, NY
Center for Computational Astrophysics (CCA) May 2021

- Developed and delivered two lectures as part of a graduate-level course, focusing on unsupervised learning and clustering algorithms.

Nonlinear Structure Formation Tehran, Iran
Sharif University of Technology Jan 2020

- Led a month-long course for ∼30 senior undergraduate and graduate students, focusing on non-perturbative approaches to cosmic structure formation.

Teaching Assistant

University of Pennsylvania Philadelphia, PA
Department of Physics & Astronomy 2018–2022

- **Cosmology (Spring 2019)**: Graduate-level course; led office hours for ∼10 students
- **Introduction to Astrophysics (Fall 2019)**: Undergraduate-level course; led office hours for ∼25 students.
- **Survey of the Universe (Fall 2018)**: Science course for non-majors; led section discussions for ∼25 students in an active learning format.

The Wharton School Philadelphia, PA
Department of Statistics & Data Science 2018–2022

- **Modern Data Mining (Spring 2020, Spring 2021)**: science course for non-majors and MBA students; led active learning format office hours for ∼30 students and guided two case study course projects.

Mentoring Experience

Graduate Research

2023–	Navya Uberoi	Yale University
2022–	Sasha Gaines	Yale University
2021–2024	Jason (Jaemyoung) Lee	University of Pennsylvania

Undergraduate Research

2023	Andrew Hicks	C.U. Boulder, REVU Program[1]
2022–	Andy Nilipour	Yale University
2018	Setareh Foroozan	Sharif University of Technology
2018	Arefe Abghari	Sharif University of Technology

[1] The Research Experience for Veteran Undergraduate, 9-week summer program for enlisted U.S. veteran undergraduates conducting STEM research.

Academic Service & Outreach

Professional Service

2024	NASA ADAP Grant Review Panel
2023	DESI Year 1 Data Release/Tutorial Coordinator
2023–	Co-Group Leader, Dark Matter Topical Group of DESI Milky Way Survey
2022–	Member of DESI Education & Public Outreach (EPO) Committee
2019–	Member of American Physical Society (APS)
2019–	Member of American Astronomical Society (AAS)
2018–	Reviewer for *APJ, PRL, PRD, PRE, JCAP, MNRAS, RASTI, A&A*

Department & University Service

2023–	Member of Yale Postdoctoral Advisory Committee (PDAC)
2022–2023	Member of Yale Time Allocation Committee (TAC)
2020 & 2021	Member of Organizing Committee for Penn Live Data Science
2019–2021	Member of Penn Diversity & Inclusion in Physics (DIP) Group

Media & Press Coverage

July 2023	The Conversation
Apr 2023	**Exploring the dark side of the universe**, Inria
Mar 2023	**Turning Back Time on Space**, Yale News

Selected Talks

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July 2024	Cosmology in the Adriatic – From PT to AI
Apr 2024	* Perimeter Institute, Cosmology & Gravitation Seminar
Feb 2024	* Yale University, Center for Astronomy and Astrophysics Colloquium
July 2023	University of Oxford, Rudolf Peierls Centre for Theoretical Physics, Cosmology Seminar
Mar 2023	Ecole de physique des Houches, Optimal Transport Theory and Applications to Physics
Aug 2022	Lorentz Center Leiden, Towards Real-Time Galactic Dynamics Workshop
July 2022	Max Planck Institute for Nuclear Physics Heidelberg, Particles, Strings and Cosmology (PASCOS)
July 2022	* IAP, Initiative in Cosmology and Physics of Astro Particles (ICAP) Seminar
Apr 2022	Center for Computational Astronomy (CCA), DDA Meeting

List of Publications

Peer Reviewed Journals

Astrophysics

15. Eigen-decomposition of Covariance matrices: An application to the BAO Linear Point
Jaemyoung Jason Lee, **Farnik Nikakhtar**, Aseem Paranjape, and Ravi K. Sheth
Physical Review D - submitted, arXiv:2407.04692 (July 2024).

14. Leveraging protohalos and scale-dependent bias to calibrate the BAO scale in real space
Sasha Gaines, **Farnik Nikakhtar**, Nikhil Padmanabhan, and Ravi K. Sheth
Physical Review D - submitted, arXiv:2408.00072 (July 2024).

13. Displacement field analysis via optimal transport: Multitracer approach to cosmological reconstruction
Farnik Nikakhtar, Ravi K. Sheth, Nikhil Padmanabhan, Bruno Lévy, and Roya Mohayaee
Physical Review D 109.12, 123512 (June 2024).

12. The Stability of the BAO Linear Point under Modified Gravity
Jaemyoung Jason Lee, Bartolomeo Fiorini, **Farnik Nikakhtar**, and Ravi K. Sheth
Physical Review D - submitted, arXiv:2406.09379 (June 2024).

11. Optimal transport reconstruction of biased tracers in redshift space
Farnik Nikakhtar, Nikhil Padmanabhan, Bruno Lévy, Ravi K. Sheth, and Roya Mohayaee
Physical Review D 108.8, 083534 (Oct. 2023).

10. Building an Acceleration Ladder with Tidal Streams and Pulsar Timing
Peter Craig, Sukanya Chakrabarti, Robyn E. Sanderson, and **Farnik Nikakhtar**
Astrophysical Journal Letters 945.2, L32 (Mar. 2023).

9. Optimal Transport Reconstruction of Baryon Acoustic Oscillations
Farnik Nikakhtar, Ravi K. Sheth, Bruno Lévy, and Roya Mohayaee
Physical Review Letters 129.25, 251101 (Dec. 2022).

8. Precision tests of CO and [CII] power spectra models against simulated intensity maps
Azadeh Moradinezhad Dizgah, **Farnik Nikakhtar**, Garrett K. Keating, and Emanuele Castorina
Journal of Cosmology and Astroparticle Physics 2022.2, 026 (Feb. 2022).

7. Smearing scale in Laguerre reconstructions of the correlation function
Farnik Nikakhtar, Ravi K. Sheth, and Idit Zehavi
Physical Review D 105.4, 043536 (Feb. 2022).

6. New Families in our Solar Neighborhood: Applying Gaussian Mixture Models for Objective Classification of Structures in the Milky Way and in Simulations
Farnik Nikakhtar, Robyn E. Sanderson, et al.
Astrophysical Journal 921.2, 106 (Nov. 2021).

5. Laguerre reconstruction of the BAO feature in halo-based mock galaxy catalogues
Farnik Nikakhtar, Ravi K. Sheth, and Idit Zehavi
Physical Review D 104.6, 063504 (Sept. 2021).

4. Laguerre reconstruction of the correlation function on baryon acoustic oscillation scales
Farnik Nikakhtar, Ravi K. Sheth, and Idit Zehavi
Physical Review D 104.4, 043530 (Aug. 2021).

3. Galaxy properties as revealed by MaNGA - III. Kinematic profiles and stellar population gradients in S0s
H. Domínguez Sánchez, M. Bernardi, **F. Nikakhtar**, B. Margalef-Bentabol, and R. K. Sheth
Monthly Notices of the Royal Astronomical Society 495.3 (July 2020).

2. The stellar mass Fundamental Plane: the virial relation and a very thin plane for slow rotators
M. Bernardi, H. Domínguez Sánchez, B. Margalef-Bentabol, **F. Nikakhtar**, and R. K. Sheth
Monthly Notices of the Royal Astronomical Society 494.4 (June 2020).

1. The Excursion set approach: Stratonovich approximation and Cholesky decomposition
Farnik Nikakhtar, Mohammadreza Ayromlou, Shant Baghram, Sohrab Rahvar, M. Reza Rahimi Tabar, and Ravi K. Sheth
Monthly Notices of the Royal Astronomical Society 478.4 (Aug. 2018).

Complex Systems

3. Revealing Higher-Order Interactions in High-Dimensional Complex Systems: A Data-Driven Approach
M. Reza Rahimi Tabar, **Farnik Nikakhtar**, Laya Parkavousi, Amin Akhshi, Ulrike Feudel, and Klaus Lehnertz
Physical Review X 14.1, 011050 (Mar. 2024).

2. Data-driven reconstruction of stochastic dynamical equations based on statistical moments
Farnik Nikakhtar, Laya Parkavousi, Muhammad Sahimi, M. Reza Rahimi Tabar, Ulrike Feudel, and Klaus Lehnertz
New Journal of Physics 25.8, 083025 (Aug. 2023).

1. Exact enumeration approach to first-passage time distribution of non-Markov random walks
Shant Baghram, **Farnik Nikakhtar**, M. Reza Rahimi Tabar, S. Rahvar, Ravi K. Sheth, Klaus Lehnertz, and Muhammad Sahimi
Physical Review E 99.6, 062101 (June 2019).

Data Release Papers

4. DESI Early Data Release Milky Way Survey Value-Added Catalogue
Sergey E. Koposov, C. Allende Prieto, […], **F. Nikakhtar**, et al.
Monthly Notices of the Royal Astronomical Society (July 2024).

3. Public Data Release of the FIRE-2 Cosmological Zoom-in Simulations of Galaxy Formation
Andrew Wetzel, Christopher C. Hayward, […], **Farnik Nikakhtar**, et al.
Astrophysical Journal Supplement 265.2, 44 (Apr. 2023).

2. APOGEE-centric Ananke Simulations in a SciServer SQL Database
Rachael L. Beaton, Suzanne Werner, […], **Farnik Nikakhtar**, et al.
Research Notes of the American Astronomical Society 6.6, 125 (June 2022).

1. The Seventeenth Data Release of the Sloan Digital Sky Surveys: Complete Release of MaNGA, MaStar, and APOGEE-2 Data
Abdurro'uf, Katherine Accetta, […], **Farnik Nikakhtar**, et al.
Astrophysical Journal Supplement 259.2, 35 (Apr. 2022).

Conference Proceedings

5. Generating synthetic star catalogs from simulated data for next-gen observatories with py-ananke
   Adrien Thob, Robyn Sanderson, Andrew Eden, **Farnik Nikakhtar**, Nondh Panithanpaisal, and Nicolás Garavito-Camargo
   American Astronomical Society Meeting Abstracts vol. 243, 134.07 (Feb. 2024).
4. Linear Point Standard Ruler Estimation with Neural Networks
   Andy Nilipour, **Farnik Nikakhtar**, and Nikhil Padmanabhan
   American Astronomical Society Meeting Abstracts vol. 55, 340.02 (Sept. 2023).
3. Probing the Galactic Potential Using Optimal Transport Theory
   Farnik Nikakhtar, Quentin Mérigot, Jason Hunt, Robyn Sanderson, Ravi K. Sheth, Roya Mohayaee, and Bruno Lévy
   AAS Division of Dynamical Astronomy Meeting vol. 54, 405.01 (May 2022).
2. New families in our solar neighborhood
   F. Nikakhtar and R. Sanderson
   American Astronomical Society Meeting vol. 236, 332.03 (June 2020).
1. Reducing X-ray Bright Galaxy Groups Images with Theli Pipeline
   Farnik Nikakhtar
   12th Asia-Pacific IAU Regional Meeting vol. 30.2 (Aug. 2015).

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