

# Ethan Nadler | Curriculum Vitae

Carnegie Observatories & University of Southern California

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## Research

### Dark Matter.....

- Inferring dark matter particle properties from small-scale structure observations;
- Modeling structure formation with novel dark matter interactions and production mechanisms.

### Computational Astrophysics.....

- Emulating the impact of baryons on small-scale structure using cosmological simulations;
- Empirically modeling the connection between (satellite) galaxies and dark matter (sub)halos.

### Near-field Cosmology.....

- Reconstructing primordial density fluctuations from the Milky Way satellite population;
- Unifying dark matter constraints from near-field, strong lensing, and high-redshift measurements.

## Positions

**Carnegie Observatories & University of Southern California**

2021–

*Postdoctoral Research Fellow*

## Education

**Stanford University**

2021

*Ph.D., Physics*

Thesis: [Faint Galaxies and Small Halos: Probes of Galaxy Formation and Dark Matter](#)

**University of California, Santa Barbara**

2016

*B.S., Physics*

Thesis: Universality in the Structure and Abundance of Dark Matter Halos

## Scientific Collaborations

**Satellites Around Galactic Analogs Survey:** Member

2019–

**DECam Local Volume Exploration (DELVE) Survey:** Member

2019–

**Rubin LSST Dark Energy Science Collaboration:** Member, Dark Matter Working Group

2018–

**Dark Energy Survey:** Member, Milky Way Working Group

2018–

## Fellowships & Awards

**Carnegie DEI Grant:** CreateNow + Carnegie: Dark Matter & Data Visualization

2022–

**XSEDE Allocation:** Cosmological Simulations of Milky Way-like Systems with Galactic Disks

2022–

**XSEDE Allocation:** Simulations of Milky Way Halos with Large Magellanic Cloud Analogs

2020–21

**NSF Graduate Research Fellow:** National Science Foundation

2018–21

**Faculty Committee Commendation of Excellence:** UCSB College of Creative Studies

2016

**Outstanding Senior Award:** UCSB Department of Physics

2016

## Mentoring

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### Graduate Student Project Advisor

2021–

- Wendy Crumrine, USC: Searching for dark matter–baryon interactions using Milky Way satellites
- Karime Maamari, USC: Simulating galaxy formation with dark matter–baryon interactions;
- Trey Driskell, USC: Modeling early structure formation in novel dark matter scenarios (see [T. Driskell, E. O. Nadler \*et al.\* 2022](#));
- Noah Glennon, UNH: Soliton orbital evolution in self-interacting axion dark matter (see [N. Glennon, E. O. Nadler \*et al.\* 2022](#));
- Sidney Mau, Stanford: Constraining the dark matter particle lifetime with dwarf galaxies (see [S. Mau, E. O. Nadler \*et al.\* 2021](#));
- Yunchong Wang, Stanford: Empirically modeling dwarf galaxy star formation histories (see [Y. Wang, E. O. Nadler \*et al.\* 2021](#));
- Elise Darragh-Ford, Stanford: Searching for dwarf galaxies and stellar streams in *Gaia* data (see [E. Darragh-Ford, E. O. Nadler \*et al.\* 2021](#));

### Undergraduate & Post-baccalaureate Student Advisor

2018–

- Juan Quiroz, Caltech '24: Modeling subhalo evolution in decaying dark matter cosmologies
- Ellen Min, Caltech '24: Code development and Python implementation for [Galacticus](#)
- Shuxing Fang, USC '22: Large Magellanic Cloud infall in self-interacting dark matter;
- Nyal McCrea, CWU '22 & Simons-NSBP Scholar: Visualizing subhalos in cosmological simulations;
- Resherle Verna, USC '20 → UT Austin: Subhalo populations in SIDM + hydrodynamic simulations;
- Deveshi Buch, Stanford '23: Constrained simulations of Milky Way-like systems;
- Veronica Pratt, Stanford '23: Statistics of Large Magellanic Cloud analogs in the SAGA Survey;
- Nicel Mohamed-Hinds, Stanford '19 → UW: Emulating hydrodynamic zoom-in simulations;
- Abigail Lee, UPenn '19 → UChicago: Subhalo disruption in galaxy clusters.

## Teaching

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### Guest Lecturer (USC)

2022

- *Advanced Cosmology*: Lecture on *Structure Formation & Galaxies*.

### Textbook Co-Author (University of California, Davis)

2022

- *A Cosmology Workbook*: [31: Structure Formation](#), [32: Galaxy Formation](#).

### Teaching Assistant (Stanford)

2017–21

- *Structure Formation & Galaxy Formation, Modern Astrophysics, Cosmology & Extragalactic Astrophysics, Origin & Development of the Cosmos, Electricity & Magnetism*.

### Course Assistant (UCSB)

2015–16

- *Relativistic Quantum Mechanics, Kinetic Theory & Relativity, Mechanics & Waves, Newtonian Mechanics*.

### Tutor (UCSB Campus Learning Assistance Services)

2015–16

- Held biweekly supplementary lectures for *Basic Physics, Linear Algebra, Differential Equations*.

## Outreach & Service

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### Conference Coordinator (KITP, [Cosmic Signals of Dark Matter Physics: New Synergies](#))

2024

### Proposal Review Panel Member (NASA Astrophysics Data Analysis Program)

2022

### CreateNow + Carnegie: Dark Matter & Data Visualization (Course Instructor)

2022

### Carnegie Observatory Lectures at Pasadena City College (Speaker)

2022

### Carnegie Observatories Lunch with an Astronomer (Speaker)

2022

### Cosmic Cocktail Hour with Carnegie Observatories (Speaker)

2022

### USC Physics Climate Committee (Member)

2021–

### UCSB Physics NSF REU (Speaker)

2021–

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| <b>San Mateo County Astronomical Society</b> (Speaker) [ <a href="#">video</a> ]             | 2021    |
| <b>Journal Referee</b> ( <i>ApJ</i> , <i>Astropart. Phys.</i> , <i>JCAP</i> , <i>MNRAS</i> ) | 2019–   |
| <b>Astronomy on Tap San Francisco</b> (Speaker and Volunteer)                                | 2018–20 |
| <b>Stanford Future Advancers of Science and Technology</b> (Physics Mentor)                  | 2017–19 |

## Media

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| <b>KIPAC Research Highlight</b> , <i>Between the worlds of the visible and invisible lies: Dark Matter</i>   | 2021 |
| <b>Fermilab Press Release</b> , <i>DES census of the smallest galaxies hones the search for dark matter</i>  | 2020 |
| <b>SLAC Press Release</b> , <i>Milky Way satellites reveal link between dark matter and galaxy formation</i> | 2020 |
| <b>AAS Nova Research Highlight</b> , <i>Constraining collisions of dark matter</i>                           | 2019 |
| <b>SLAC Press Release</b> , <i>Satellite galaxies provide new clues about dark matter</i>                    | 2019 |
| <b>KIPAC Research Highlight</b> , <i>Dark matter subhalo disruption: insights from machine learning</i>      | 2018 |

## Invited Presentations

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| <b><i>The Faint End of the Galaxy–Halo Connection</i></b>  | 2023    |
| KITP, Building a Physical Understanding of Galaxy Evolution [ <a href="#">video</a> ]  |         |
| <b><i>Dark Matter Constraints from Small-Scale Structure</i></b>   | 2022    |
| CERN Theory Institute, New Physics from Galaxy Clustering [ <a href="#">video</a> , <a href="#">slides</a> ]                         |         |
| <b><i>Symphony: Cosmological Zoom-in Simulations over Four Decades of Host Halo Mass</i></b>   | 2022    |
| Caltech, GalFRESCA [ <a href="#">slides</a> ]  |         |
| <b><i>Dark Matter Physics + Rubin LSST</i></b>   | 2022    |
| LSST Dark Energy Science Collaboration, CosmoPalooza   |         |
| <b><i>Towards Precision Near-Field Cosmology</i></b>   | 2021–   |
| KIPMU, Astro Lunch Seminar   |         |
| UC Riverside, Astronomy Seminar  |         |
| Fermilab, Cosmic Physics Center Seminar [ <a href="#">video</a> ]  |         |
| <b><i>Dark Matter Constraints from a Unified Analysis of Strong Lenses and Satellite Galaxies</i></b>                                | 2021    |
| LSST DESC Dark Matter Working Group  |         |
| Virginia Tech Center for Neutrino Physics, Journal Club  |         |
| <b><i>The Faintest Galaxies and their Dark Matter Halos</i></b>  | 2020–21 |
| Caltech, TAPIR Seminar   |         |
| Minnesota Institute for Astrophysics, Cosmology Lunch Seminar  |         |
| Harvard-Smithsonian Center for Astrophysics, GCSP Seminar [ <a href="#">video</a> ]  |         |
| International Centre for Theoretical Sciences, Less Travelled Path of Dark Matter [ <a href="#">video</a> , <a href="#">slides</a> ] |         |
| UC Santa Cruz, FLASH Seminar   |         |
| UC Berkeley Center for Cosmological Physics, Cosmology Seminar [ <a href="#">slides</a> ]  |         |
| STScI, The Local Group: Assembly and Evolution   |         |
| KITP, The Galaxy–Halo Connection Across Cosmic Time: Recent Updates [ <a href="#">video</a> ]  |         |
| LIneA, Webinar [ <a href="#">video</a> , <a href="#">slides</a> ]  |         |
| KIPAC, Astrophysics Colloquium [ <a href="#">video</a> ]   |         |
| Fermilab, New Perspectives [ <a href="#">slides</a> ]  |         |
| USC, CosmoLab Seminar  |         |
| BSM Pandemic Seminar [ <a href="#">video</a> , <a href="#">slides</a> ]  |         |
| Fermilab, Wine & Cheese  |         |

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| <b><i>Milky Way Satellites: Probes of Dark Matter Microphysics</i></b><br>University of Chicago, Cosmic Controversies [ <a href="#">slides</a> ]<br>KICP, LSST Dark Matter Workshop [ <a href="#">slides</a> ]<br>Institute for Advanced Study, Astro Coffee<br>Johns Hopkins, High Energy Physics/Cosmology Seminar<br>UC Berkeley, LSST DESC Winter Collaboration Meeting | 2019 |
| <b><i>Modeling Subhalos and Satellites in Milky Way-like Systems</i></b><br>KICP, Near-Field Cosmology with DES DR1 [ <a href="#">slides</a> ]<br>KITP, The Small-Scale Structure of Cold(?) Dark Matter [ <a href="#">video</a> , <a href="#">slides</a> ]<br>UC Berkeley Center for Cosmological Physics, Cosmology Seminar [ <a href="#">slides</a> ]                    | 2018 |
| <b><i>Predicting Realistic Subhalo Populations</i></b><br>KITP, The Galaxy–Halo Connection Across Cosmic Time   | 2017 |

## First & Co-Authored Publications

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- E. O. Nadler**, A. Benson, T. Driskell, X. Du, and V. Gluscevic. *Growing the First Galaxies' Merger Trees*. 2023, [MNRAS](#), **521**, 3201.
- E. O. Nadler**, P. Mansfield, Y. Wang, X. Du *et al.* *Symphony: Cosmological Zoom-in Simulation Suites over Four Decades of Host Halo Mass*. 2023, [ApJ](#), **945**, 159.
- E. O. Nadler**, A. Banerjee, S. Adhikari, Y.-Y. Mao, and R. H. Wechsler. *The Effects of Dark Matter and Baryonic Physics on the Milky Way Subhalo Population in the Presence of the Large Magellanic Cloud*. 2021, [ApJL](#), **920**, L11.
- E. O. Nadler**, S. Birrer, D. Gilman, R. H. Wechsler, X. Du, A. Benson, A. Nierenberg, and T. Treu. *Dark Matter Constraints from a Unified Analysis of Strong Gravitational Lenses and Milky Way Satellite Galaxies*. 2021, [ApJ](#), **917**, 7.
- S. Das & **E. O. Nadler**. *Constraints on the epoch of dark matter formation from Milky Way satellites*. 2021, [PRD](#), **103**, 043517.
- E. O. Nadler** & A. Drlica-Wagner *et al.* (DES Collaboration). *Constraints on Dark Matter Properties from Observations of Milky Way Satellite Galaxies*. 2021, [PRL](#), **126**, 091101.
- E. O. Nadler**, A. Banerjee, S. Adhikari, Y.-Y. Mao, and R. H. Wechsler. *Signatures of Velocity-dependent Dark Matter Self-interactions in Milky Way-mass Halos*. 2020, [ApJ](#), **896**, 112.
- E. O. Nadler** & R. H. Wechsler *et al.* (DES Collaboration). *Milky Way Satellite Census. II. Galaxy-Halo Connection Constraints Including the Impact of the Large Magellanic Cloud*. 2020, [ApJ](#), **893**, 48.
- E. O. Nadler**, V. Gluscevic, K. K. Boddy, and R. H. Wechsler. *Constraints on Dark Matter Microphysics from the Milky Way Satellite Population*. 2019, [ApJL](#), **878**, L32.
- E. O. Nadler**, Y.-Y. Mao, G. M. Green, and R. H. Wechsler. *Modeling the Connection between Subhalos and Satellites in Milky Way-like Systems*. 2019, [ApJ](#), **873**, 34.
- E. O. Nadler**, Y.-Y. Mao, R. H. Wechsler, S. Garrison-Kimmel, and A. Wetzel. *Modeling the Impact of Baryons on Subhalo Populations with Machine Learning*. 2018, [ApJ](#), **859**, 129.
- E. O. Nadler**, A. Perko, and L. Senatore. *On the bispectra of very massive tracers in the Effective Field Theory of Large-Scale Structure*. 2018, [JCAP](#), **1**, 058.
- E. O. Nadler**, S. P. Oh, and S. Ji. *On the apparent power law in CDM halo pseudo-phase space density profiles*. 2017, [MNRAS](#), **470**, 500.



## Publications

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- R. An, V. Gluscevic, **E. O. Nadler**, and Y. Zhang. *Can Neutrino Self-interactions Save Sterile Neutrino Dark Matter?* [2301.08299](#) (PRL submitted).
- E. Darragh-Ford, J. F. Wu *et al.* (DESI Collaboration, incl. **E. O. Nadler**). *Target Selection and Sample Characterization for the DESI LOW-Z Secondary Target Program.* [2212.07433](#) (ApJ submitted).
- P. Hopkins, **E. O. Nadler**, M. Grudić, X. Shen *et al.* *Novel Conservative Methods for Adaptive Force Softening in Collisionless and Multi-Species N-Body Simulations.* [2212.06851](#) (MNRAS submitted).
- D. Yang, **E. O. Nadler**, and Hai-bo Yu. *Strong Dark Matter Self-interactions Diversify Halo Populations Within and Surrounding the Milky Way.* [2211.13768](#) (ApJ in press).
- W. Cerny *et al.* (DELVE Collaboration, incl. **E. O. Nadler**). *Six More Ultra-Faint Milky Way Companions Discovered in the DECam Local Volume Exploration Survey.* [2209.12422](#) (ApJ submitted).
- S. Yang, X. Du, Z. C Zeng, A. Benson, F. Jiang, **E. O. Nadler et al.** *Gravothermal solutions of SIDM halos: mapping from constant to velocity-dependent cross section.* [2205.02957](#) (ApJ in press).
- S. Wagner-Carena, J. Aalbers, S. Birrer, **E. O. Nadler et al.** *From Images to Dark Matter: End-To-End Inference of Substructure From Hundreds of Strong Gravitational Lenses.* 2023, [ApJ](#), **942**, 75.
- [T. Driskell](#), **E. O. Nadler**, J. Mirocha, A. Benson, K. K. Boddy *et al.* *Structure Formation and the Global 21-cm Signal in the Presence of Coulomb-like Dark Matter-Baryon Interactions.* 2022, [PRD](#), **106**, 103525.
- Major contributions: Interpretation of structure formation predictions in interacting dark matter models.
- [N. Glennon](#), **E. O. Nadler**, N. Musoke, A. Banerjee, C. Prescod-Weinstein, and R. H. Wechsler. *Tidal disruption of solitons in self-interacting ultralight axion dark matter.* 2022, [PRD](#), **105**, 123540.
- Major contributions: Conceptualization and interpretation of soliton tidal disruption simulations.
- S. Mau, **E. O. Nadler**, R. H. Wechsler, A. Drlica-Wagner, K. Bechtol *et al.* (DES Collaboration). *Milky Way Satellite Census. IV. Constraints on Decaying Dark Matter from Observations of Milky Way Satellite Galaxies.* 2022, [ApJ](#), **932**, 128.
- Major contributions: Performed cosmological decaying dark matter simulations and derived constraints.
- S. Bhattacharyya, S. Adhikari, A. Banerjee, S. More, A. Kumar, **E. O. Nadler et al.** *The Signatures of Self-Interacting Dark Matter and Subhalo Disruption on Cluster Substructure.* 2022, [ApJ](#), **932**, 30.
- J. F. Wu, J. E. G. Peek, E. J. Tollerud, Y.-Y. Mao, **E. O. Nadler et al.** *Extending the SAGA Survey (xSAGA) I: Satellite Radial Profiles as a Function of Host Galaxy Properties.* 2022, [ApJ](#), **927**, 121.
- D. Nguyen, D. Sarnaaik, K. K. Boddy, **E. O. Nadler**, and V. Gluscevic. *Observational constraints on dark matter scattering with electrons.* 2021, [PRD](#), **104**, 103521.
- A. Drlica-Wagner, J. Carlin, D. L. Nidever *et al.* (DELVE Collaboration, incl. **E. O. Nadler**). *The DECam Local Volume Exploration Survey: Overview and First Data Release.* 2021, [ApJS](#), **256**, 2.
- Y. Wang, **E. O. Nadler**, Y.-Y. Mao, S. Adhikari, R. H. Wechsler *et al.* *UNIVERSEMACHINE: Predicting Galaxy Star Formation over Seven Decades of Halo Mass with Zoom-in Simulations.* 2021, [ApJ](#), **915**, 116.
- Major contributions: Interpretation of dwarf galaxy star formation history predictions, simulation analysis.
- E. Darragh-Ford, **E. O. Nadler**, S. McLaughlin, and R. H. Wechsler. *Searching for Dwarfs in Gaia DR2 Phase-space Data using Wavelet Transforms.* 2021, [ApJ](#), **915**, 48.
- Major contributions: Pilot study, search algorithm development, predictions for number of detected dwarfs.
- K. Maamari, V. Gluscevic, K. K. Boddy, **E. O. Nadler**, and R. H. Wechsler. *Bounds on velocity-dependent dark matter–proton scattering from Milky Way satellite abundance.* 2021, [ApJL](#), **907**, L46.
- Major contributions: Development of numerical techniques to constrain interacting dark matter models.
- Y.-Y. Mao, M. Geha, R. H. Wechsler, B. Weiner, E. J. Tollerud, **E. O. Nadler et al.** *The Saga Survey. II. Building a Statistical Sample of Satellite Systems around Milky Way-like Galaxies.* 2021, [ApJ](#), **907**, 85.

- Major contributions: Interpretation of SAGA observations in the context of galaxy–halo connection models.

A. Drlica-Wagner, K. Bechtol, S. Mau, M. McNanna, **E. O. Nadler** *et al.* (DES Collaboration). *Milky Way Satellite Census. I. The Observational Selection Function for Milky Way Satellites in DES Y3 and Pan-STARRS DR1*. 2020, [ApJ](#), 893, 47.

- Major contributions: Machine-learning modeling of satellite detection sensitivity, simulation analysis.

S. Mau, W. Cerny *et al.* (DELVE Collaboration, incl. **E. O. Nadler**). *Two Ultra-Faint Milky Way Stellar Systems Discovered in Early Data from the DECam Local Volume Exploration Survey*. 2020, [ApJ](#), 890, 136.

C. E. Martínez-Vázquez *et al.* (DES Collaboration, incl. **E. O. Nadler**). *Search for RR Lyrae stars in DES ultrafaint systems: Grus I, Kim 2, Phoenix II, and Grus II*. 2019, [MNRAS](#), 490, 2183.

K. M. Stringer *et al.* (DES Collaboration, incl. **E. O. Nadler**). *Identification of RR Lyrae stars in multiband, sparsely-sampled data from the Dark Energy Survey using template fitting and Random Forest classification*. 2019, [AJ](#), 158, 16.

## White Papers

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A. Drlica-Wagner *et al.* *Report of the Topical Group on Cosmic Probes of Dark Matter for Snowmass 2021*. 2022, [2209.08215](#)

A. Banerjee *et al.* *Snowmass2021 Cosmic Frontier White Paper: Cosmological Simulations for Dark Matter Physics*. 2022, [2203.07049](#)

K. Bechtol *et al.* *Snowmass2021 Cosmic Frontier White Paper: Dark Matter Physics from Halo Measurements*. 2022, [2203.07354](#).

Y.-Y. Mao *et al.* *Snowmass2021: Vera C. Rubin Observatory as a Flagship Dark Matter Experiment*. 2022, [2203.07252](#).

K. Boddy *et al.* *Astrophysical and Cosmological Probes of Dark Matter*. 2022, [2203.06380](#).

S. Gezari *et al.* *R2-D2: Roman and Rubin – From Data to Discovery*. 2022, [2202.12311](#).

V. Gluscevic *et al.* *Cosmological Probes of Dark Matter Interactions: The Next Decade*. 2019, [1903.05140](#).

J. Simon *et al.* *Dynamical Masses for a Complete Census of Local Dwarf Galaxies*. 2019, [1903.047435](#).

K. Bechtol *et al.* *Dark Matter Science in the Era of LSST*. 2019, [1903.04425](#).

A. Drlica-Wagner & Y.-Y. Mao *et al.* *Probing the Fundamental Nature of Dark Matter with the Large Synoptic Survey Telescope*. 2019, [1902.01055](#).

- Major contributions: Forecasts and theoretical development for LSST dwarf galaxy dark matter constraints.

## Interdisciplinary Studies

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M. Chu, B. S. Desikan, **E. O. Nadler** *et al.* *Signal in Noise: Exploring Meaning Encoded in Random Character Sequences with Character-Aware Language Models*. [Proceedings of the 60th Annual Meeting of the Association for Computational Linguistics](#), 7120

B. S. Desikan, T. Hull, **E. O. Nadler** *et al.* *comp-syn: Perceptually Grounded Word Embeddings with Color*. 2020, [Proceedings of the 28th International Conference on Computational Linguistics](#), 1744.

D. Guilbeault, **E. O. Nadler** *et al.* *Color associations in abstract semantic domains*. 2020, [Cognition](#) 201, 104306.