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

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

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 & Extragalctic 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

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–*

San Mateo County Astronomical Society (Speaker) [video] *2021*
Journal Referee (*ApJ*, *Astropart. Phys.*, *JCAP*, *MNRAS*) *2019–*
Astronomy on Tap San Francisco (Speaker and Volunteer) *2018–20*
Stanford Future Advancers of Science and Technology (Physics Mentor) *2017–19*

Media

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

Invited Presentations

Dark Matter Constraints from Small-Scale Structure *2022*
CERN Theory Institute, New Physics from Galaxy Clustering [video, slides]

Symphony: Cosmological Zoom-in Simulations over Four Decades of Host Halo Mass *2022*
Caltech, GalFRESCA [slides]

Dark Matter Physics + Rubin LSST *2022*
LSST Dark Energy Science Collaboration, CosmoPalooza

Towards Precision Near-Field Cosmology *2021–*
KIPMU, Astro Lunch Seminar
UC Riverside, Astronomy Seminar
Fermilab, Cosmic Physics Center Seminar [video]

Dark Matter Constraints from a Unified Analysis of Strong Lenses and Satellite Galaxies *2021*
LSST DESC Dark Matter Working Group
Virginia Tech Center for Neutrino Physics, Journal Club

The Faintest Galaxies and their Dark Matter Halos *2020–21*
Caltech, TAPIR Seminar
Minnesota Institute for Astrophysics, Cosmology Lunch Seminar
Harvard-Smithsonian Center for Astrophysics, GCSP Seminar [video]
International Centre for Theoretical Sciences, Less Travelled Path of Dark Matter [video, slides]
UC Santa Cruz, FLASH Seminar
UC Berkeley Center for Cosmological Physics, Cosmology Seminar [slides]
STScI, The Local Group: Assembly and Evolution
KITP, The Galaxy–Halo Connection Across Cosmic Time: Recent Updates [video]
LIneA, Webinar [video, slides]
KIPAC, Astrophysics Colloquium [video]
Fermilab, New Perspectives [slides]
USC, CosmoLab Seminar
BSM Pandemic Seminar [video, slides]
Fermilab, Wine & Cheese

Milky Way Satellites: Probes of Dark Matter Microphysics *2019*
University of Chicago, Cosmic Controversies [slides]

KICP, LSST Dark Matter Workshop [slides]
Institute for Advanced Study, Astro Coffee
Johns Hopkins, High Energy Physics/Cosmology Seminar
UC Berkeley, LSST DESC Winter Collaboration Meeting

Modeling Subhalos and Satellites in Milky Way-like Systems *2018*
KICP, Near-Field Cosmology with DES DR1 [slides]
KITP, The Small-Scale Structure of Cold(?) Dark Matter [video, slides]
UC Berkeley Center for Cosmological Physics, Cosmology Seminar [slides]

Predicting Realistic Subhalo Populations *2017*
KITP, The Galaxy–Halo Connection Across Cosmic Time

First & Co-Authored Publications

E. O. Nadler, P. Mansfield, Y. Wang, X. Du *et al*. *Symphony: Cosmological Zoom-in Simulation Suites over Four Decades of Host Halo Mass*. 2209.02675 (ApJ submitted).

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

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 submitted).

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 submitted).

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*. 2203.00690 (ApJ submitted).

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*. 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

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

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.