

# Ethan Nadler | Curriculum Vitae

Carnegie Observatories & University of Southern California

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## Research

### Dark Matter.....

- Measuring dark matter microphysics using observations of small-scale cosmic structure;
- Simulating structure formation in dark matter models beyond CDM.

### Computational Astrophysics.....

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

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

- Reconstructing primordial density fluctuations from dwarf galaxy populations;
- Unifying dark matter constraints from near-field, strong lensing, and high-redshift data.

## 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 Analogs with Galactic Disks

2022–23

**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–

- 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. 2022](#));
- 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, & High-school Student Advisor

2018–

- Logan White (Simons–NSBP Scholar), NCSU '25: Halo mass function evolution beyond CDM;
- Juan Quiroz, Caltech '24: Modeling subhalo evolution in decaying dark matter models;
- Derek Rodriguez, USC Hybrid High '23 → UCLA: Symphony simulation analysis;
- 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 (Simons–NSBP Scholar), CWU '22 → Synrad: Visualizing subhalo populations;
- 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 → Tufts: 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

### Carnegie Observatories Lectures at the Huntington (Speaker) [[video](#)]

2023

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

2022

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

2022

### Carnegie Observatories 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 (Postdoctoral & Staff Representative)

2021–

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

## Media

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

## Invited Presentations

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<i>SIDM Subhalos in Milky Way and Strong Lens Analogs</i>	2023
Pollica Summer Workshop, Self-Interacting Dark Matter: Models, Simulations and Signals	
<i>Cosmological Simulations with Novel Dark Matter Physics</i>	2023
UCLA, Dark Matter 2023 [ <a href="#">slides</a> ]	
KICP, Astronomy & Astrophysics Seminar	
<i>The Faint End of the Galaxy–Halo Connection</i>	2023
KITP, Building a Physical Understanding of Galaxy Evolution [ <a href="#">video</a> ]	
<i>Dark Matter Constraints from Small-Scale Structure</i>	2022
CERN Theory Institute, New Physics from Galaxy Clustering [ <a href="#">video</a> , <a href="#">slides</a> ]	
<i>Symphony: Cosmological Zoom-in Simulations over Four Decades of Host Halo Mass</i>	2022
Caltech, GalFRESKA [ <a href="#">slides</a> ]	
<i>Dark Matter Physics + Rubin LSST</i>	2022
LSST Dark Energy Science Collaboration, CosmoPalooza	
<i>Towards Precision Near-Field Cosmology</i>	2021
KIPMU, Astro Lunch Seminar	
UC Riverside, Astronomy Seminar	
Fermilab, Cosmic Physics Center Seminar [ <a href="#">video</a> ]	
<i>Dark Matter Constraints from a Unified Analysis of Strong Lenses and Satellite Galaxies</i>	2021
LSST DESC Dark Matter Working Group	
Virginia Tech Center for Neutrino Physics, Journal Club	
<i>The Faintest Galaxies and their Dark Matter Halos</i>	2020–21
Caltech, TAPIR 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 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> ]	
BSM Pandemic Seminar [ <a href="#">video</a> , <a href="#">slides</a> ]	

## ***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**

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**E. O. Nadler**, D. Yang, and H.-B. Yu. *A Self-interacting Dark Matter Solution to the Extreme Diversity of Low-mass Halo Properties*. 2023, [ApJL](#), **958**, L39.

**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. Benson, T. Driskell, X. Du, and V. Gluscevic. *Growing the First Galaxies' Merger Trees*. 2023, [MNRAS](#), **521**, 3201.

**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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N. Glennon, N. Musoke, **E. O. Nadler**, C. Prescod-Weinstein, and R. H. Wechsler. *Dynamical friction in self-interacting ultralight dark matter*. [2312.07684](#) (PRD submitted).

M. McNanna, K. Bechtol, S. Mau, **E. O. Nadler et al.** (DES Collaboration). *A search for faint resolved galaxies beyond the Milky Way in DES Year 6: A new faint, diffuse dwarf satellite of NGC 55*. [2309.044679](#) (ApJ in press).

- Major contributions: Developed dwarf galaxy population predictions and interpreted NGC 55 satellite.

N. Ahvazi, A. Benson, L. V. Sales, **E. O. Nadler et al.** *A comprehensive model for the formation and evolution of the faintest Milky Way dwarf satellites*. [2308.13599](#) (MNRAS submitted).

- Major contributions: Interpreted galaxy–halo connection and Milky Way satellite predictions.

P. Mansfield, E. Darragh-Ford, Y. Wang, **E. O. Nadler**, and R. H. Wechsler. *Symfind: Addressing the Fragility of Subhalo Finders and Revealing the Durability of Subhalos*. [2308.10926](#) (ApJ submitted).

D. Yang, **E. O. Nadler**, H.-B. Yu, and Y.-M. Zhong. *A Parametric Model for Self-Interacting Dark Matter Halos*. [2305.16176](#) (JCAP submitted).

- Major contributions: Provided and interpreted comparisons to cosmological SIDM simulations.

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*. 2023, [MNRAS](#), **525**, 5951.

- Major contributions: Conceptualized softening algorithms and interpreted small-scale structure results.

E. Darragh-Ford *et al.* (DESI Collaboration, incl. **E. O. Nadler**). *Target Selection and Sample Characterization for the DESI LOW-Z Secondary Target Program*. 2023, [ApJ](#), **954**, 149.

R. An, V. Gluscevic, **E. O. Nadler**, and Y. Zhang. *Can Neutrino Self-interactions Save Sterile Neutrino Dark Matter?* 2023, [ApJL](#), **954**, L18.

- Major contributions: Developed framework for sterile neutrino constraints.

A. Banerjee, S. Das, A. Maharana, **E. O. Nadler**, and R. K. Sharma. *Nonthermal warm dark matter limits from small-scale structure*. 2023, [PRD](#), **108**, 043518.

- Major contributions: Derived small-scale structure constraints and interpreted results.

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*. 2023, [ApJ](#), **953**, 1.

D. Yang, **E. O. Nadler**, and H.-B. Yu. *Strong Dark Matter Self-interactions Diversify Halo Populations Within and Surrounding the Milky Way*. 2023, [ApJ](#), **949**, 67.

- Major contributions: Performed cosmological SIDM simulations and interpreted dwarf galaxy predictions.

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*. 2023, [ApJ](#), **946**, 47.

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: Interpreted structure formation predictions for 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: Conceptualized and interpreted 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.

- J. 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. Sarnaik, K. K. Boddy, **E. O. Nadler**, and V. Gluscevic. *Observational constraints on dark matter scattering with electrons*. 2021, [PRD, 104, 103521](#).
- A. Drlica-Wagner 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. *UNIVERSE MACHINE: Predicting Galaxy Star Formation over Seven Decades of Halo Mass with Zoom-in Simulations*. 2021, [ApJ, 915, 116](#).  
 ◦ Major contributions: Interpreted dwarf galaxy star formation history predictions; analyzed simulations.
- 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: Piloted and developed search algorithm; predicted 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: Developed 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: Provided theoretical predictions for SAGA satellite populations and interpreted results.
- 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: Developed machine-learning model of satellite detection sensitivity; analyzed simulations.
- S. Mau 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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- J. Han et al. *NANCY: Next-generation All-sky Near-infrared Community survey*. 2023, [2306.11784](#).
- 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](#)  
 ◦ Major contributions: Developed simulation algorithm section and flowchart for tests of dark matter physics.
- K. Bechtol et al. *Snowmass2021 Cosmic Frontier White Paper: Dark Matter Physics from Halo Measurements*. 2022, [2203.07354](#).  
 ◦ Major contributions: Developed ultra-faint dwarf galaxy section and power spectrum visualization.
- 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 *et al.* *Probing the Fundamental Nature of Dark Matter with the Large Synoptic Survey Telescope*. 2019, [1902.01055](#).
- Major contributions: Developed dwarf galaxy section and forecasted dark matter constraints.

## Interdisciplinary Publications

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- E. O. Nadler**, E. Darragh-Ford, B. S. Desikan *et al.* *Divergences in Color Perception between Deep Neural Networks and Humans*. 2023, [Cognition 241, 105621](#).
- 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*. 2022, [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](#).