

Ethan Nadler | Curriculum Vitae

Carnegie Observatories & University of Southern California

813 Santa Barbara Street – Pasadena, CA 91101 – USA

✉ enadler@carnegiescience.edu • 🌐 eonadler • 📍 Ethan O. Nadler

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

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

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

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–

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| UCSB Physics NSF REU (Speaker) | 2021– |
| San Mateo County Astronomical Society (Speaker) [video] | 2021 |
| Journal Referee (<i>ApJ</i> , <i>Astropart. Phys.</i> , <i>JCAP</i> , <i>MNRAS</i> , <i>PRL</i> , <i>Language & 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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| UC Riverside News, <i>New dark matter theory explains two puzzles in astrophysics</i> | 2023 |
| Quanta Magazine, <i>In a Monster Star's Light, a Hint of Darkness</i> | 2023 |
| 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>Revealing Dark Matter and Galaxy Formation with Small-Scale Structure</i> | 2024 |
| Rice, Astronomy & Astrophysics Seminar | |
| UC San Diego, Astrophysics Colloquium | |
| Caltech, TAPIR Seminar | |
| <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 |
| UC Riverside, GalFRESCA | |
| UCLA, Dark Matter 2023 [slides] | |
| KICP, Astronomy & Astrophysics Seminar | |
| <i>The Faint End of the Galaxy–Halo Connection</i> | 2023 |
| KITP, Building a Physical Understanding of Galaxy Evolution [video] | |
| <i>Dark Matter Constraints from Small-Scale Structure</i> | 2022 |
| CERN Theory Institute, New Physics from Galaxy Clustering [video , slides] | |
| <i>Symphony: Cosmological Zoom-in Simulations over Four Decades of Host Halo Mass</i> | 2022 |
| Caltech, GalFRESCA [slides] | |
| <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 [video] | |
| <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 | |

The Faintest Galaxies and their Dark Matter Halos

2020–21

Harvard-Smithsonian Center for Astrophysics, GCSP Seminar [[video](#)]

International Centre for Theoretical Sciences, Less Travelled Path of Dark Matter [[video](#), [slides](#)]

KITP, The Galaxy–Halo Connection Across Cosmic Time: Recent Updates [[video](#)]

LIneA, Webinar [[video](#), [slides](#)]

KIPAC, Astrophysics Colloquium [[video](#)]

Fermilab, New Perspectives [[slides](#)]

BSM Pandemic Seminar [[video](#), [slides](#)]

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, V. Gluscevic, T. Driskell, R. H. Wechsler, L. A. Moustakas, *et al.* *Forecasts for Galaxy Formation and Dark Matter Constraints from Dwarf Galaxy Surveys*. 2401.10318 (ApJ submitted).

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

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 in press).

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 in press).

- Major contributions: Ran cosmological SIDM simulations and interpreted comparisons to parametric model.

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*. 2024, [ApJ](#), 961, 126

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

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. 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 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

- 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

- 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](#).