

Evan H. Anders

CIERA
Northwestern University
Evanston, IL 60201

email: evan.anders@northwestern.edu
website: evanhandlers.bitbucket.io
Google Scholar: [pOxWQ5sAAAAJ](https://scholar.google.com/citations?user=pOxWQ5sAAAAJ)
arXiv: [anders_e_1](https://arxiv.org/a/anders_e_1)
 : [evanhandlers](https://github.com/evanhandlers)

Research Interests

Computational fluid dynamics and its applications to stellar interiors and atmospheres.
Convection and its interactions with stably-stratified layers, rotation, and magnetism.

Education

- May 2020 **Ph.D.**, *University of Colorado – Boulder, Astrophysical & Planetary Sciences.*
Thesis title: “Fundamental Studies of Stratified Stellar Convection: Simulations and Theory”
- Dec. 2017 **M.S.**, *University of Colorado – Boulder, Astrophysical & Planetary Sciences.*
- May 2014 **B.S.**, *Whitworth University, Physics.*

Research Experience

- Sept 2023– **Postdoctoral Scholar**, *Kavli Institute for Theoretical Physics, Santa Barbara, CA.*
- 2020–2023 **Postdoctoral Fellow**, *CIERA, Northwestern University, Evanston, IL.*
- Summer 2020 **Postdoctoral Researcher**, *LASP, Boulder, CO.*
- 2018–2020 **NASA NESSF Graduate Fellow**, *University of Colorado & LASP, Boulder, CO.*
- 2015–2018 **George Ellery Hale Graduate Fellow**, *NSO & LASP, Boulder, CO.*
- Summer 2015 **Graduate Research Assistant**, *LASP, Boulder, CO.*
- 2013 **NSF Summer Undergraduate Research Fellow**, *LIGO, Hanford, WA.*
- 2012 **DOE Summer Undergraduate Laboratory Intern**, *PNNL, Richland, WA.*

Grants & Fellowships Awarded

- 2023– **KITP Postdoctoral Scholar**, Santa Barbara.
Fellowship covers salary and attendance to all KITP workshops
- 2020–2023 **CIERA Postdoctoral Fellowship**, Evanston, IL.
Fellowship covers salary and provides \$15,000 yearly research stipend

- 2018-2020 **NASA Earth and Space Science Fellowship**, \$90,000, Boulder, CO.
 Fundamental Studies Into the Solar Convective Conundrum: Do Giant Cells Exist?
 Grant Number 80NSSC18K1199
- 2015-2018 **NSO George Ellery Hale Graduate Fellowship**, Boulder, CO.
 Fellowship covers tuition, fees, and graduate research stipend for three full years.
 Fellowship overview available online at <https://www.nso.edu/students/hale-fellowships/>

Publications List

- † - I was a co-first-author on this paper
 * - This paper was led by someone I mentor

Peer-reviewed Journal Articles

- 2023 23. **Anders, E.H.**; Lecoanet, D.; Cantiello, M.; Burns, K.J.; Hyatt, B.A.; Kaufman, E.; Townsend, R.H.D.; Brown, B.P.; Vasil, G.M.; Oishi, J.S.; Jermyn, A.S. In prep.
The photometric variability of massive stars from gravity waves
- *22. Powers, W.T.; **Anders, E.H.**; Brown, B.P.; and Oishi, J.S. In prep (PRFluids).
Fundamental studies of internally heated fully compressible convection
- †21. **Anders, E.H.** and Pedersen, M.G. Under review (Galaxies special edition).
Convective boundary mixing in main-sequence stars: theory and empirical constraints
20. Fuentes, J.R.; Cumming, A.; Castro-Tapia, M.; **Anders, E.H.**. Under review (ApJ).
Heat transport and convective velocities in compositionally-driven convection in neutron star and white dwarf interiors
- *19. Cresswell, I.G.; **Anders, E.H.**; Brown, B.P.; Oishi, J.S.; and Vasil, G.M.
 Submitted to PRFluids.
Force Balances in Strong-Field Magnetoconvection Simulations
- 2022 †18. Fraser, A.E.; Joyce, M.; **Anders, E.H.**; Tayar, J.; Cantiello, M. [ApJ 941 164](#).
Characterizing Observed Extra Mixing Trends in Red Giants using the Reduced Density Ratio from Thermohaline Models.
- *17. Fuentes, J.R.; Cumming, A.; **Anders, E.H.** [PRF 7, 124501](#).
Layer formation in a stably-stratified fluid cooled from above. Towards an analog for Jupiter and other gas giants.
- *16. Kaufman, E.; Lecoanet, D.; **Anders, E.H.**; Brown, B.P.; Vasil, G.M.; Oishi, J.S.; and Burns, K.J. [MNRAS 517, 3](#).
The Stability of Prendergast Magnetic Fields
15. Jermyn, A.S.; **Anders, E.H.**; Lecoanet, D.; and Cantiello, M. [ApJS 262, 19](#).
An Atlas of Convection in Main Sequence Stars.
14. Jermyn, A.S.; **Anders, E.H.**; Lecoanet, D.; and Cantiello, M. [ApJ 929, 182](#).
Convective Penetration in Early-Type Stars

13. **Anders, E.H.**; Jermyn, A.S.; Lecoanet, D.; Fraser, A.E.; Cresswell, I.G.; Joyce, M.; and Fuentes, J.R. [ApJL 928, L10](#).
Schwarzschild and Ledoux are equivalent on evolutionary timescales
12. Jermyn, A.S.; **Anders, E.H.**; and Cantiello, M. [ApJ 926, 221](#).
A Transparent Window into Early-Type Stellar Variability
11. **Anders, E.H.**; Jermyn, A.S.; Lecoanet, D.; and Brown, B.P., [ApJ 926, 169](#).
Stellar convective penetration: parameterized theory and dynamical simulations
- 2021 *10. O'Connor, L.; Lecoanet, D.; and **Anders, E.H.**, [Physical Review Fluids 6, 093501](#).
Marginally-Stable Thermal Equilibria of Rayleigh-Bénard Convection
9. Lecoanet, D.; Cantiello, M.; **Anders, E.H.**; Quataert, E.; Couston, L.; Bouffard, M.; Favier, B.; and Le Bars, M., [MNRAS 508, 1, 132-143](#).
Surface Manifestation of Stochastically Excited Internal Gravity Waves
8. Van Kooten, S.J.; **Anders, E.H.**; and Cranmer, S.R, [ApJ 913, 69](#)
A Refined Model of Convectively-Driven Flicker in Kepler Light Curves
7. Oishi, J.S.; Burns, K.J.; Clark, S.E.; **Anders, E.H.**; Brown, B.P.; Vasil, G.M.; and Lecoanet, D, [JOSS 6\(62\), 3079](#).
eigentools: A Python package for studying eigenvalue problems with an emphasis on stability
- 2020 6. **Anders, E.H.**; Vasil, G.M.; Brown, B.P.; and Korre, Lydia, [Physical Review Fluids 5, 083501](#).
Convective dynamics with mixed temperature boundary conditions: why thermal relaxation matters and how to accelerate it
- 2019 5. **Anders, E.H.**; Lecoanet, D.; and Brown, B.P., [ApJ 884, 65](#).
Entropy Rain: Dilution and Compression of Thermals in Stratified Domains
4. **Anders, E.H.**; Manduca, C.M.; Brown, B.P.; Oishi, J.S.; Vasil, G.M., [ApJ 872, 2](#).
Predicting the Rossby Number in Convective Experiments
- 2018 3. **Anders, E.H.**; Brown, B.P; and Oishi, J. S., [Physical Review Fluids 3, 083502](#).
Accelerated evolution of convective simulations
- 2017 2. **Anders, E.H.** and Brown, B.P., [Physical Review Fluids 2, 083501](#).
Convective heat transport in stratified atmospheres at low and high Mach number
- 2016 1. Karki, S.; Tuyenbayev, D.; Kandhasamy, S.; Abbott, B.P.; Abbott, T.D.; **Anders, E.H.**; Berliner, J.; Betzwieser, J.; Cahillane, C.; Canete, L.; Conley, C.; Daveloza, H.P.; De Lillo, N.; Gleason, J.R.; Goetz, E.; Izumi, K.; Kissel, J.S.; Mendell, G.; Quetschke, V; Rodruck, M.; Sachdev, S.; Sadecki, T.; Schwinberg, P.B.; Sottile, A.; Wade, M.; Weinstein, A.J., West, M.; and Savage, R.L., [Review of Scientific Instruments 87, 114503](#).
The Advanced LIGO photon calibrators

Other Publications

- 2022 4. Featherstone, N. et. al. incl. **Anders, E.H.** Decadal Review Whitepaper.
The Puzzling Structure of Solar Convection: Window into the Dynamo
3. **Anders, E.H.**; Bauer, E.B.; Jermyn, A.S.; Van Kooten, S.J.; Brown, B.P.;
Hester, E.W.; Wilkinson, M.; Goldberg, J.A.; Varesano, T.; Lecoanet, D. [ArXiv](#);
[April fool's paper](#).
Moosinesq Convection in the Cores of Moosive Stars
2. **Anders, E.H.**; Jermyn, A.S.; Lecoanet, D.; Fuentes, J.R.; Korre, L.; Brown,
B.P.; Oishi, J.S.; [RNAAS 6, 41](#).
Convective Boundary Mixing Processes
1. Jermyn, A.S.; **Anders, E.H.**; Lecoanet, D.; Cantiello, M.; and Goldberg, J.A.;
[RNAAS 6, 29](#).
Measures of Convective Efficiency

Invited Presentations

- 2023 22. Title TBD.
Seminar. Leuven. Mar. 31.
21. Convectively-driven gravity waves in massive stars
CIERA Theory Group Meeting. Northwestern University. Feb. 17.
- 2022 20. Why do Massive Stars have “Inflated” Cores?
Astronomy Department colloquium. University of Wisconsin-Madison. Dec. 1.
19. Mixing and wave generation at the convective boundary in massive stars.
Applied Mathematics Seminar. Durham University. Nov. 15.
18. Convective boundary mixing and wave generation in the cores of massive stars.
Fluids & MHD Seminar. Leeds University. Nov. 10.
17. Why are convective cores in massive stars bigger than expected?
Discussion Seminar. Isaac Newton Institute DYT2 programme. Nov. 7.
16. The mystery of convective boundary mixing in the cores of massive stars.
TAPIR Seminar. Caltech. Oct. 28.
15. Why are convective cores in stars bigger than expected?
Bildsten Group Meeting. KITP. Oct. 27.
14. Chalk Talk: Convective Boundary Mixing in Massive Stars.
Compact Objects Research Group Seminar. CCA, Flatiron Institute. Oct. 13.
13. Chalk Talk: Dedalus & Convective Boundary Mixing in Massive Stars.
Quataert Group Meeting. Princeton University. Oct. 12.
12. Modern mysteries in stellar convection & a brief intro to fluid dynamics
CIERA REU Seminar. Northwestern University. July 28.
11. A modern mystery in stellar convection & Dedalus is a flexible tool
Research Seminar. Newcastle University. July 12.

- 2021 10. Stellar convective penetration: parameterized theory and dynamical simulations
Virtual. Astro coffee. The Ohio State University. Oct. 27.
9. Convective Penetration Probably Parameterizes Convective Overshoot
Virtual. Stellar Physics Group Presentation. CCA, Flatiron Institute. July 6.
8. Convective Penetration Probably Parameterizes Convective Overshoot
Virtual. Seminar. "Kavli Summer Program in Astrophysics 2021: Fluid dynamics of the Sun and stars." July 5.
7. Massive Star Variability
Virtual. Pre-recorded research intro lecture. "Kavli Summer Program in Astrophysics 2021: Fluid dynamics of the Sun and stars." June 8.
- 2020 6. Massive Star Variability and other fun with Dedalus
CIERA, Northwestern University. CIERA Virtual Happy Hour Short Talk. Nov. 20.
5. Entropy Rain and the Solar Convective Conundrum: Dilution and Compression of Individual Convective Downflows
Nordita, Stockholm. "The Shifting Paradigm of Stellar Convection: From Mixing Length Concepts to Realistic Turbulence Modeling" workshop. Mar. 4.
- 2019 4. Entropy Rain and the Solar Convective Conundrum: Dilution and Compression of Individual Convective Downflows
Princeton University. Star Formation/ISM Rendezvous (SFIR) Seminar. Dec. 4.
3. Entropy Rain: Dilution and Compression of Thermals in Stratified Domains
University of Colorado – Boulder. Applied Math Geophysical and Astrophysical Fluid Dynamics (GAFD) Seminar. Oct. 1.
- 2018 2. Predicting the Rossby Number in Stratified, Compressible Convection
National Solar Observatory. Solar Focus Meeting. Dec. 7.
- 2017 1. Fundamental studies in stratified convection at low and high Mach Number
University of Colorado – Boulder. Applied Math Dynamics Seminar. Nov. 11.

Service

Referee Service

ApJ	2023-, 1 total articles
MNRAS	2022-, 1 total articles
Sci. Rep.	2022-, 1 total articles
JFM	2021-, 1 total articles
JAS	2020-, 2 total articles
DIRAC	2020-, 1 total grants

Departmental Service

2022-2023	Member of CIERA Climate Action Team
2022	Member of CIERA Justice, Equity, Diversity, and Inclusion (JEDI) committee

- 2021 Chair of CIERA K12 outreach taskforce
- 2020 Member of CIERA K12 outreach taskforce
- 2019-2020 Member of newly-formed admissions setup committee
- 2018-2019 Voting member of graduate admissions committee
Graduate student member of exams committee
- 2017-2018 Voting member of graduate admissions committee
- 2016-2017 Voting member of hiring committee for director of Fiske Planetarium
Graduate student member of search committee for NSO/CU faculty appointment
Graduate student member of exams committee
- 2015-2016 Graduate student member of search committee for three-year NSO/CU appointment

--- Awards & Honors

- 2019 **AAS 233 Chambliss Graduate Student Poster Contest**, *Honorable Mention*.
- 2016 **Comprehensive Exam II High Pass**, University of Colorado – Boulder.
Awarded for the defense of publication-quality research
- 2016 **Carl Hansen Graduate Fellowship**, \$1,000, University of Colorado – Boulder.
Awarded to a graduate student studying stellar interiors
- 2014 **President's Award for Outstanding Academic Achievement**, Whitworth Univ..
Awarded to students graduating with 4.0 GPAs

--- Teaching Experience and Professional Development

Courses & Labs Taught

- Summer 2017 **ASTR 2600: Introduction to Scientific Programming**, *Co-Instructor of Record*.
- 2014-2017 **ASTR 1010: Introductory Astronomy I (Lab)**, *Graduate Lab Instructor, 4 sections*.

Guest Lectures

- 2020 **PS361: Nuclear Physics**, *Whitworth University*, "Life and Death of Stars", Dec. 9.
- 2015 **ASTR 1010: Intro. Astro. I**, *Univ. of CO*, "Patterns in the Solar System", Mar. 10.

Teaching Assistantships

- 2015-2016 **ASTR 1010: Introductory Astronomy I**, *Lecture Teaching Assistant, 2 sections*.

Pedagogy Training

- 2022 **CIRTL Course: An Introduction to Evidence-Based Undergraduate STEM Teaching**, *Student*.
UCSC ISEE PDP 20-year conference, *Participant*.
- 2019 **UCSC ISEE Professional Development Program**, *Design Team Leader*.
Led team over a 100-hour program to design and teach a day-long inquiry activity on buoyancy.

- 2017 **UCSC ISEE Professional Development Program, Participant.**
Designed and taught a day-long inquiry activity on exoplanet transits.
- 2016-2017 **Lead Graduate Teacher, Astro. Department,** University of Colorado, Boulder, CO.
Led video consultations, ran pedagogy workshops, interfaced with Graduate Teacher Program.

Outreach

Long-term programs

- 2016-2019 **CU STARS, Student Coordinator,** University of Colorado, Boulder, CO.
CU STARS (CU Boulder Science, Technology, and Astronomy RecruitS) visits underserved schools across all of Colorado and gives high school students an opportunity to learn about and engage with space science. Graduate students serve as mentors to undergraduates, help design and improve outreach courses, and ensure outreach visits run smoothly.
- 2014-2017 **Sommers-Bausch Observatory Open House Series, Host & Telescope Operator,** University of Colorado, Boulder, CO.
Operated telescopes and answered questions from the public during free observing nights.

Visualization & Print Media

- 2021 **“Exoplanets” Pathfinder Pamphlet,** CIERA Pathfinder Series, Evanston, IL.

One-day events

- 2022 **Baxter Summer Scholars Astro. Day,** Northwestern University, Evanston, IL.
- 2021 **Baxter Summer Scholars Astro. Day,** Northwestern University, Evanston, IL.
- 2019 **CU Boulder MASP PEAC Science Day,** University of Colorado, Boulder, CO.
Sommers-Bausch Observatory Astro. Day, University of Colorado, Boulder, CO.
- 2018 **Sommers-Bausch Observatory Astro. Day,** University of Colorado, Boulder, CO.
- 2017 **CU Boulder MASP PEAC Science Day,** University of Colorado, Boulder, CO.
Sommers-Bausch Observatory Astro. Day, University of Colorado, Boulder, CO.

Contributed Presentations

- 2022 **APS Division of Fluid Dynamics, Talk,** Indianapolis, IN.
Convectively-driven waves in a massive star
- 2021 **APS Division of Fluid Dynamics, Talk,** Pheonix, AZ.
Convective penetration exists and we found it
- KITP Probes of Transport in Stars conference, Talk,** Santa Barbara, CA.
Stellar Convective Penetration: Context, Theory, and Simulations
- 2020 **APS Division of Fluid Dynamics, Virtual Talk,** Chicago, IL.
Convection in the Full Sphere: Predicting the Rossby Number of Mean & Fluctuating Flows
- American Astronomical Society’s 235th Meeting, Dissertation Talk,** Honolulu, HI.
Numerical Explorations in Stellar Convection

- 2019 **APS Division of Fluid Dynamics**, *Talk*, Seattle, WA.
Dilution and Compression of Thermals in Stratified Domains
Compressible Convection Conference, *Talk*, Newcastle Upon Tyne, UK.
Entropy Rain: Dilution and Compression of Turbulent Thermals in Stratified Domains
Stellar Hydro Days V, *Poster*, Exeter, UK.
Accelerating the evolution of atmospheric structure in convective simulations
American Astronomical Society's 233rd Meeting, *Poster*, Seattle, WA.
Accelerating the evolution of simulated convective atmospheres
- 2018 **APS Division of Fluid Dynamics**, *Talk*, Atlanta, GA.
Predicting the Rossby number in stratified, compressible convection
- 2017 **APS Division of Fluid Dynamics**, *Talk*, Denver, CO.
The effects of Mach number and rotation on heat transport in stratified convection
Compressible Convection Conference, *Talk*, Lyon, Fr.
Convective heat transport in stratified atmospheres at low and high Mach number
- 2016 **APS Division of Fluid Dynamics**, *Talk*, Portland, OR.
Sustained shear flows in stratified convection
AAS Solar Physics Division, *Poster*, Boulder, CO.
Boundary Layer Structure in Stratified Convection

References

Prof. Benjamin P. Brown

University of Colorado, Boulder
Dept. Astrophysical & Planetary Sciences
Email: bpbrown@colorado.edu

Prof. Daniel Lecoanet

Northwestern University
Dept. Engineering Sciences & Applied Mathematics
CIERA
Email: daniel.lecoanet@northwestern.edu

Dr. Matteo Cantiello

Flatiron Institute
Center for Computational Astrophysics
Princeton University
Dept. Astrophysical Sciences
Email: mcantiello@flatironinstitute.org