# Daniel Lecoanet

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## PROFESSIONAL EXPERIENCE

**Princeton University** Sept 2016-Present
Center for Theoretical Science Postdoc Fellow & Lyman Spitzer Postdoc Fellow

## EDUCATION

**University of California – Berkeley**
PhD, Physics May 2016

**University of Cambridge**
Masters of Advanced Study, Applied Mathematics, with Distinction June 2011

**University of Wisconsin – Madison**
BS, Mathematics, Physics, with Comprehensive Honors May 2010

## RESEARCH INTERESTS

**Astrophysical & Geophysical Fluids:** convection; dynamo; tides; waves
**Numerical Methods:** pseudospectral methods; high performance computing
**Nonlinear Optimization:** transition to turbulence; instanton; Swift-Hohenberg

## AWARDS AND HONORS

- Princeton Center for Theoretical Science Postdoc Fellow (2016-2019).
- Lyman Spitzer Jr. Postdoc Fellow (2016-2021).
- Hubble Fellowship (declined).
- Einstein Fellowship (declined).
- Mary Elizabeth Uhl Prize – Berkeley Astrophysics Department Award (2016).
- Fluid Dynamics Research Prize (2015)
- Fannie and John Hertz Foundation Graduate Fellowship (2011-2016).
- Winston Churchill Foundation Scholarship (2010-2011) for study in the U.K.
- NSF Graduate Research Fellowship (2011-2014).
- KITP Graduate Fellowship (2014).
- Woods Hole Geophysical Fluid Dynamics Fellow (2013).
- Goldwater Scholar, 2008-2010.

## REFEREED JOURNAL ARTICLES

1. **D. Lecoanet**, N. Jeevanjee, "Entrainment in Resolved, Turbulent Dry Thermals." *Submitted to JAS*.

2. G. M. Vasil, **D. Lecoanet**, K. J. Burns, J. S. Oishi, B. P. Brown, "Tensor calculus in spherical coordinates using Jacobi polynomials. Part-I: Mathematical analysis and derivations." *Submitted to JCP*.

3. **D. Lecoanet**, G. M. Vasil, K. J. Burns, B. P. Brown, J. S. Oishi, "Tensor calculus in spherical coordinates using Jacobi polynomials, Part-II: Implementation and Examples." *Submitted to JCP*.

4. L.-A. Couston, **D. Lecoanet**, B. Favier, M. Le Bars, "The energy flux spectrum of internal gravity waves generated by turbulent convection." *JFM Rapids* **854** R3 (2018).

5. L.-A. Couston, **D. Lecoanet**, B. Favier, M. Le Bars, "Order out of chaos: slowly-reversing mean flows emerge from turbulently-generated internal waves." *PRL* **120** 244505 (2018).

6. N. Tarshish, N. Jeevanjee, **D. Lecoanet**, "Buoyant Motion of a Turbulent Thermal." *JAS* ***75*** 3233-3244 (2018).

7. O. Mickelin, J. Słomka, K. J. Burns, **D. Lecoanet**, G. M. Vasil, L. M. Faria, J. Dunkel, "Anomalous chained turbulence in actively driven flows on spheres." *PRL* **120** 164503 (2018).

8. **D. Lecoanet**, R. R. Kerswell, "The Connection between Nonlinear Optimal Perturbations and Instantons." *PRE* **97** 012212 (2018).

9. L.-A. Couston, **D. Lecoanet**, B. Favier, M. Le Bars, "Dynamics of Mixed Convective—Stably-Stratified Fluids." *PRF* **2** 094804 (2017).

10. **D. Lecoanet**, G. M. Vasil, J. Fuller, M. Cantiello, K. J. Burns, "Conversion of Internal Gravity Waves into Magnetic Waves." *MNRAS* **466** 2181-2193 (2017).

11. **D. Lecoanet**, J. Schwab, E. Quataert, L. Bildsten, F. X. Timmes, K. J. Burns, G. M. Vasil, J. S. Oishi, B. P. Brown, "Turbulent Chemical Diffusion in Convectively Bounded Carbon Flames." *ApJ* **832** 71 (2016).

12. **D. Lecoanet**, M. McCourt, E. Quataert, K. J. Burns, G. M. Vasil, J. S. Oishi, B. P. Brown, J. Stone, R. O'Leary, "A Validated Nonlinear Kelvin-Helmholtz Benchmark for Numerical Hydrodynamics." *MNRAS* **455** 4274-4288 (2016).

13. G. M. Vasil, K. J. Burns, **D. Lecoanet**, S. Olver, B. P. Brown, J. S. Oishi, "Tensor calculus in polar coordinates using Jacobi polynomials." *JCP* **325** 53-73 (2016).

14. J. Fuller, M. Cantiello, **D. Lecoanet**, E. Quataert, "The spin rate of pre-collapse stellar cores: wave driven angular momentum transport in massive stars." *ApJ* **810** 101 (2015).

15. M. Le Bars, **D. Lecoanet**, J. M. Aurnou, S. Perrard, A. Ribeiro, L. Rodet, P. Le Gal, "Experimental study of internal wave generation by convection in water." *Fluid Dyn Res* **47** 045502 (2015).

16. **D. Lecoanet**, M. Le Bars, K. J. Burns, E. Quataert, G. M. Vasil, B. P. Brown, J. S. Oishi, "Numerical Simulations of Internal Wave Generation by Convection in Water." *PRE* **91** 063016 (2015).

17. P. Marcus, S. Pei, C.-H. Jiang, J. Barranco, P. Hassanzadeh, **D. Lecoanet**, "Zombie Vortex Instability I: The "Dead" Zones of Protoplanetary Disks are Not Dead." *ApJ* **808** 87 (2015).

18. **D. Lecoanet**, B. P. Brown, E. G. Zweibel, K. J. Burns, J. S. Oishi, G. M. Vasil, "Conduction in Low Mach Number Flows: Part I Linear & Weakly Nonlinear Regimes." *ApJ* **797** 94-105 (2014).

19. J. Fuller, **D. Lecoanet**, M. Cantiello, B. Brown, "Angular Momentum Transport via Internal Gravity Waves in Evolving Stars." *ApJ* **796** 17-28 (2014).

20. G. M. Vasil, **D. Lecoanet**, B. P. Brown, E. G. Zweibel, "Energy Conservation and Gravity Waves in Sound-proof Treatments of Stellar Interiors: Part II Lagrangian Constrained Analysis." *ApJ* **773** 169-191 (2013).

21. **D. Lecoanet**, E. Quataert, "Internal Gravity Wave Excitation by Turbulent Convection." *MNRAS* **430** 2363-2376 (2013).

22. **D. Lecoanet**, I. J. Parrish, E. Quataert, "The Dynamics of Rayleigh-Taylor Stable and Unstable Contact Discontinuities with Anisotropic Thermal Conduction." *MNRAS* **423** 1866-1882 (2012).

23. **D. Lecoanet**, E. G. Zweibel, R. H. D. Townsend, Y.-M. Huang, "Violation of Richardson's Criterion via Introduction of a Magnetic Field." *ApJ* **712** 1116-1128 (2010).

24. **D. Lecoanet**, F. C. Adams, A. M. Bloch, "Mean Motion Resonances in Extrasolar Planetary Systems with Turbulence, Interactions, and Damping." *ApJ* **692** 659-676 (2009).

25. A. Mitra, J. P. Wojcik, **D. Lecoanet**, T. Muller, R. West, "A Bis(silaselenone) with Two Donor-Stabilized Si=Se Bonds from an Unexpected Stereoconvergent Hydrolysis of a Diselenadisiletane." *Angewandte Chemie* **48** 4069-4072 (2009).

## INVITED PRESENTATIONS

1. Cornell, Astrophysics Lunch Seminar. "Dynamics at Stellar Radiative-Convective Interfaces." Nov 7, 2018.
2. Cornell, Scientific Computing (SCAN) Seminar. "Code Comparison Using the Dedalus PDE Solver." Nov 5, 2018.
3. University of Alberta, Physics Colloquium. "Dynamics at Stars' Inner Boundaries." Nov 2, 2018.
4. University of Wisconsin – Madison, Plasma Physics Seminar. "Wave Conversion from Stellar Magnetic Fields" Oct 29, 2018.
5. Flatiron Institute, Flatware Conference, w/ Keaton Burns & Jeff Oishi. "Dedalus: A flexible framework for solving differential equations using spectral methods" Oct 24, 2018.
6. GFDL, Lunchtime Seminar. "Testing Parameterizations of Convective Overshoot" Oct 17, 2018.
7. NCAR, GTP workshop on Waves, Turbulence, and Large-Scale Structures in Rotating Magnetic Fluids. "Mean Flow Interaction with Convectively Generated Internal Waves," Sep 10, 2018. https://youtu.be/ny0ivAWQaSY?list=PLUJIX4Fd9aciZeRyyr38T141_aJ_Lfae3&t=3550
8. UCSB, Kavli Institute for Theoretical Physics. "Using Dedalus, a flexible, Python-based, spectral PDE-solver," May 16, 2018. http://online.kitp.ucsb.edu/online/blayers18/dedalus/
9. UCSB, Kavli Institute for Theoretical Physics. "Convection and Entrainment in Stars," May 7, 2018. http://online.kitp.ucsb.edu/online/blayers18/lecoanet/
10. University of Illinois, Astrophysical Seminar. "Veracity and Analysis of Astrophysical Simulations," Feb 28, 2018.
11. University of Sydney, Sydney Dynamics Group Seminar. "Model hierarchies for computational data analysis," Jan 12, 2018.
12. Northwestern University, Astrophysics Journal Club. "The Turbulent Diffusivity of Convective Overshoot," Nov 7, 2017.

13. Northwestern University, Applied Math Colloquium. “Model Hierarchies for Data Analysis in Fluid Dynamics,” Nov 6, 2017.

14. University of Exeter, Astrophysics Seminar. “The Turbulent Diffusivity of Convective Overshoot,” Sept 26, 2017.

15. IRPHE, Marseille, Seminar. “Conversion of Internal Waves into Magnetic Waves in Stars,” Sept 15, 2017.

16. Woods Hole Oceanographic Institute, Summer Geophysical Fluid Dynamics Program. “Measuring Core Stellar Magnetic Fields using Wave Conversion,” July 19, 2017.

17. Astronum conference, St Malo, France. “Shear Flow Instabilities with Finite Volume and Spectral Methods,” Jun 27, 2017.

18. UCSB, Kavli Institute for Theoretical Physics. “Dedalus tutorial,” Apr 25, 2017. http://online.kitp.ucsb.edu/online/stars17/dedalus/

19. Northwestern University, CIERA Lunch. “Measuring Core Stellar Magnetic Fields using Wave Conversion,” Apr 17, 2017.

20. UCSB, Kavli Institute for Theoretical Physics. “Discussion on rotation, convection, and waves,” Apr 13, 2017. http://online.kitp.ucsb.edu/online/stars17/lecoanet/

21. Princeton University, Analysis of PDEs/Fluids Seminar. “Mixing in Compressible Hydrodynamics as Diffusivities Approach Zero,” Mar 16, 2017.

22. University of Sydney, Applied Maths Seminar. “Magnetic Wave Conversion in Stellar Interiors,” Mar 1, 2017.

23. Johns Hopkins University, Center for Environment and Applied Fluid Mechanics Seminar. “The Turbulent Diffusivity of Convective Overshoot,” Feb 10, 2017.

24. UCSB, Center for Interdisciplinary Research in Fluids Seminar. “The Turbulent Diffusivity of Penetrative Convection,” Jan 25, 2017.

25. UCSB, Kavli Institute for Theoretical Physics. “Dedalus: A Flexible Framework for Spectrally Solving Partial Differential Equations,” Jan 16, 2017. http://online.kitp.ucsb.edu/online/transturb17/lecoanet/

26. University of New Hampshire, Integrated Applied Mathematics Seminar. “The Turbulent Diffusivity of Convective Overshoot,” Nov 10, 2016.

27. NCAR, GTP workshop on Turbulent and Waves in Flows Dominated by Rotation. “The Turbulent Diffusivity of Convective Overshoot,” Aug 18, 2016.

https://www.youtube.com/watch?v=8vvCNCqWkGY&index=1&list=PLUJIX4Fd9aci91IIo7tySxsf6hvBvy9g_

28. IRPHE, Marseille, Seminar. “The Turbulent Diffusivity of Convective Overshoot,” July 8, 2016.

29. Grenoble, Geodynamo Group Seminar. “The Turbulent Diffusivity of Convective Overshoot,” June 24, 2016.

30. IRPHE, Marseille, Tutorial lectures. “The Dedalus Pseudo-Spectral Framework for Solving Partial Differential Equations,” June 1-2, 2016.

31. University of Sydney, Spectral Workshop. “Kelvin-Helmholtz Instability in Spectral and Godunov Codes,” Feb 25, 2016.

32. Caltech, TAPIR Seminar. “Wave Excitation by Turbulent Stellar Convection,” Oct 30, 2015.

33. UCSD, Scripps Institution of Oceanography, CASPO Seminar. “Volumetric Excitation of Internal Waves,” Oct 28, 2015.

34. UCLA, Earth, Planetary, & Space Sciences Seminar. “Convective Excitation of Internal Waves,” Oct 26, 2015.

35. Harvard Earth & Planetary Sciences, Graduate Student & Postdoc Seminar. “Internal Wave Excitation by Convection,” Sep 24, 2015.

36. MIT, Physical Mathematics Seminar. “Internal Wave Excitation by Turbulent Convection,” Sep 22, 2015.

37. Center for Astrophysics, Harvard, Small Scale Phenomena Seminar. “How Do We Know if a Simulation is Correct?” Sep 21, 2015.

38. Courant Institute, NYU, Applied Math Lab Seminar. “Internal Wave Excitation by Turbulent Convection,” Sep 17, 2015.

39. Woods Hole Oceanographic Institute, Summer Geophysical Fluid Dynamics Program. “Internal Wave Excitation by Turbulent Convection,” July 3, 2015.

40. Society for Industrial and Applied Mathematics, Dynamical Systems. Session: Wave-turbulence Interactions in Geophysical and Astrophysical Fluid Dynamics. “Internal Wave Generation by Convection,” May 17, 2015.

41. Ecole Normale Supériere – Paris, Journal Club. “Thermal Conduction Models in Low Mach Number Flows,” Sep 19, 2014.

42. IRPHE, Marseille, Seminar. "Simulations of Convective Excitation of Internal Waves in Water," Sep 5, 2014.

43. UCSB, Kavli Institute for Theoretical Physics, presentation at Wave-Mean Flow Interaction program, with B. Brown & J. Oishi. "A Demonstration of the "Dedalus" Modeling Framework," May 28, 2014. http://online.kitp.ucsb.edu/online/waveflows14/dedalus/

44. UCSB, Center for Interdisciplinary Research in Fluids Seminar. "Convective Excitation of Internal Waves in Water," Feb 19, 2014.

45. Woods Hole Oceanographic Institute, GFD fellow presentation. "Nonlinear Optimal Perturbations," Aug 20, 2013.

46. American Geophysical Union, Meeting of the Americans. Session: Waves and Instabilities in Surface and Internal Planetary Fluid Flows. "Excitation of Internal Gravity Waves by Turbulent Stellar Convection," May 2013.

47. University of California – Santa Cruz, GAFD Seminar. "Generating Internal Gravity Waves with Turbulent Convection," Jan 24, 2013.

48. University of California – Berkeley, Fluids Seminar. "Anisotropic Conduction Along Magnetic Field Lines: New and Old Instabilities," Nov 7, 2012.

49. Canadian Institute for Theoretical Astrophysics, Seminar. "Rayleigh-Taylor Instabilities in a Dilute Plasma," Apr 12, 2012. http://hosting.epresence.tv/CITA/1/watch/426.aspx

## TEACHING AND MENTORING EXPERIENCE

1. **CISM Winter School Lecturer** (2018)
   Gave 4.5 hours of lectures to grad students, postdocs, and researchers, on waves and instabilities in stars
2. **Undergraduate mentor** (2011-2016)
   Mentoring four undergraduates through the Berkeley Compass Project
3. **Research project advisor** (fall 2011 & 2012)
   Supervised small groups of freshmen in semester-long research projects through the Berkeley Compass Project
4. **Graduate student instructor** (fall 2011)
   Taught introductory electromagnetism for biology majors (class size ~20)
5. **Peer mentor tutor** (2007-2010)
   Taught small groups of undergraduates taking introductory physics classes

## SERVICE

**Journal Referee:** Astronomy & Astrophysics; Astrophysical Journal Letters; Frontiers in Earth Science; International Journal of Thermal Sciences; Journal of Fluid Mechanics; JFM Rapids; Monthly Notices of the Royal Astronomical Society; Physical Review Fluids; Physics Letters A; Physics of Plasmas

**Conference Organizer:** "Convection in Nature," PCTS Conference, Feb 2018 (co-organized with Nadir Jeevanjee); "Fluid Mechanics of Planets and Stars," CISM Winter School, April 2018 (co-organized with Michael Le Bars).

**Berkeley Fluids Seminar:** co-organizer (2013-2016) & PI (2014-2016)