

# Benjamin Brown

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## Professional development

I received a B.S. (with high distinction) in Physics from Harvey Mudd College in Claremont, CA in 2003 and began graduate studies at the University of Colorado at Boulder later that year. There I received a M.S. in 2005 and a Ph.D. in 2009 from the Department of Astrophysical and Planetary Sciences. From October 2009 to September 2013, I was a National Science Foundation (NSF) Astronomy and Astrophysics Postdoctoral Fellow (AAPF) at the University of Wisconsin at Madison, and an associate specialist at the Kavli Institute for Theoretical Physics (KITP) in Santa Barbara, California from September 2013 to July 2014. Since August 2014, I have been an assistant professor in the Department of Astrophysical and Planetary Sciences and the Laboratory for Atmospheric and Space Physics at University of Colorado, Boulder.

## Research focus

My research focuses on astrophysical fluid dynamics and magnetohydrodynamics (MHD) of stellar interiors and planetary atmospheres. This research is conducted on national supercomputers using the open-source and massively parallel Dedalus pseudospectral framework; I am a core developer within that open-source project. My stellar research focuses especially on fundamental physical aspects of global-scale dynamo action and the properties of convection, studying how large-scale fields can be built in the convection zone of a star. Further research is exploring how such dynamos couple to the stably-stratified radiative interior through tachoclines of shear and penetrative convection, and has led to improved treatments of gravity waves within anelastic and other low-mach number models. New research avenues are exploring the magnetorotational instability within the solar interior, and new treatments for radiative transfer that could enable radiative magnetohydrodynamic simulations from the core of a star to its surface. In planetary atmospheres, I study internal gravity wave driving and convective and wave-driven transport of chemical species. We have strong connections with the stellar structure modelling communities, including MESA and CESAM, and results from our fluid dynamical models are being connected with astrophysical observations and laboratory based dynamo experiments.

## Teaching focus

I teach primarily at three levels within the Department of Astrophysical and Planetary Sciences. At the undergraduate level, I teach large, non-major science classes (ASTR 1000: Solar system, typical enrollment 200 students). At the graduate level I teach extensively with the APS graduate core (ASTR 5400: Introduction to Fluids, ASTR 5540: Mathematical Methods, ASTR 5550: Observations and Statistics), and I also teach at the advanced graduate level both in APS (ASTR 5410: Fluid Instabilities, Wave and Turbulence) and in the Applied Math department (Geophysical/Astrophysical Fluid Dynamics Seminar). I am a member of Dedalus School, a project dedicated to creating opportunities for online learning of advanced numerical modelling techniques in astrophysics. I mentor students in research at the undergraduate and graduate level, including students outside of my core research group, and regularly participate in other departmental mentoring activities within the undergraduate student body.

## Teaching and outreach experience

### Teaching

Spring	2021	ASTR-5400: Introduction to Fluid Dynamics	graduate	(22 students; online)	
Spring	2020	ASTR-5400: Introduction to Fluid Dynamics	graduate	(24 students)	
Spring	2020	APPM Joint Geophysical/Astrophysical Fluid Dynamics Seminar (co-organizer)	graduate	(~ 15 students)	
Fall	2019	ASTR-1000: Solar System (MWF)	undergraduate	(194 students)	
Fall	2019	ASTR-1000: Solar System (TuTh)	undergraduate	(195 students)	
Fall	2019	APPM Joint Geophysical/Astrophysical Fluid Dynamics Seminar (co-organizer)	graduate	(~ 15 students)	
Spring	2019	ASTR-1030: Solar System (co-taught w/ Prof. Madigan)	undergraduate	(77 students)	
Spring	2019	ASTR-5550: Observations and Statistics	graduate	(11 students)	
Spring	2019	APPM Joint Geophysical/Astrophysical Fluid Dynamics Seminar (co-organizer)	graduate	(~ 10 students)	
Fall	2018	ASTR-5410: Fluid Instabilities, Waves and Turbulence	graduate	(16 students)	
Fall	2018	APPM Joint Geophysical/Astrophysical Fluid Dynamics Seminar (co-organizer)	graduate	(~ 10 students)	
Spring	2018	ASTR-5400: Introduction to Fluid Dynamics	graduate	(19 students)	
Fall	2017	ASTR-1000: Solar System (TuTh)	undergraduate	(~ 200 students)	
Summer	2017	Lecturer in Fluid Dynamics at Other World Labs exoplanetary science summer school	graduate	(~ 20 students)	UC Santa Cruz
Spring	2017	ASTR-5550: Observations and Statistics	graduate	(11 students)	
Fall	2016	ASTR-1000: Solar System (TuTh)	undergraduate	(~ 200 students)	
Fall	2015	ASTR-5540: Mathematical Methods	graduate	(9 students)	
Fall	2014	ASTR-5540: Mathematical Methods	graduate	(10 students)	
Prior to CU Boulder					
Spring	2013	Being a Professional Scientist: Career Skills in Astronomy & Astrophysics	graduate	(~ 15 students)	UW Madison
Fall	2012	AST 310: Stellar Interiors (co-taught w/ Prof. Zweibel)	undergraduate	(27 students)	UW Madison
Spring	2011	Being a Professional Scientist: Career Skills in Astronomy & Astrophysics	graduate	(~ 15 students)	UW Madison

## Advising

### Student advising

		graduate students: current Masters	
Imogen Cresswell	2019–present	APS	
Whitney Powers	2019–present	APS	
		graduate students: completed Masters	
Ryan Orvedahl	2014–2016	APS	
Evan Anders	2014–2016	APS	
Jhett Bordwell	2014–2016	APS	
Ryan Díaz-Pérez	2017–2018	APS	
Gabriel Ortiz-Pena	2017–2019	APS	
		graduate students: completed PhD	
Jhett Bordwell	2014–2019	APS	
Evan Anders	2014–2020	APS	
		graduate students: co-advised	
Raven Larson	2018–2019	APS	
Jessica Roberts	2014–2016	APS	
		undergraduate students: research and Undergraduate Research Opportunities Program (UROP)	
Taylor Quist	2015–2018	APS	UROP and research
Christopher Panella	2016–2017	Physics & Math	UROP and research
Yun Wen	2016–2018	Physics	UROP and research
Carlos Bicas	2018–2019	APS	UROP and research
Linnea Wolniewicz	2019–present	APS	research
		undergraduate students: honors thesis	
Annie O'Connor	2020–present	APS	advisor

### Postdocs mentored through the Hale program

name	dates	current position
Jean-Francois Cossette	2014 – 2016	Scientist, Environment and Climate Change Canada
Fang Fang	2015 – 2017	Research Assistant Professor, West Virginia University
Alicia Aarnio	2016 – 2018	Assistant Professor, UNC Greensboro
Feng Chen	2017 – 2019	Nanjing University, China
Lydia Korre	2018 – present	current Hale Fellow
Benoit Tremblay	2019 – present	current Hale Fellow

### Students mentored prior to arriving at CU Boulder

Research mentor for five undergraduate students at U. Wisconsin: Jacob Swan, Elise Larson, Jesse Nims, Garrett Frankson, Kevin Meany (May 2010–2013)

External mentor for two graduate students at U. Colorado: Kyle Augustson & Nicholas Nelson (May 2007–2013)

## Exam committee service

### undergraduate students

Justin Nicoski	2020	Honors Thesis	CU Physics
Morgan Baxter	2020	Honors Thesis	Bates College Physics

### graduate students: Masters

Hilary Egan	2015	Comps II	CU APS	non-advocate chair
Evan Anders	2016	Comps II	CU APS	research advisor
Jhett Bordwell	2016	Comps II	CU APS	research advisor
Piyush Agrawal	2016	Comps II	CU APS	
Daniel Everding	2016	Comps II	CU APS	
Tristan Weber	2016	Comps II	CU APS	
Ryan Orvedahl	2016	Comps II	CU APS	research advisor
Loren Matilsky	2017	Comps II	CU APS	non-advocate chair
Ryan Horton	2017	Comps II	CU APS	non-advocate chair
Aaron Stemo	2017	Comps II	CU APS	
Avery Schiff	2017	Comps II	CU APS	
Ryan Díaz-Pérez	2018	Comps II	CU APS	research advisor
Connor Bice	2018	Comps II	CU APS	non-advocate chair
Elizabeth Butler	2018	Comps II	CU APS	
Samantha Walker	2018	Comps II	CU APS	non-advocate chair
Gabriel Ortiz-Pena	2019	Comps II	CU APS	research advisor
Brian Alden	2019	Comps II	CU APS	
Neil Bassett	2020	Comps II	CU APS	non-advocate chair
Tyler Gorda	2016	Comps III	CU Physics	
Blair Seidlitz	2021	Comps III	CU Physics	

### graduate students: PhD

Jesse Lord	2014	PhD	CU APS	
Ben Greer	2015	PhD	CU APS	
Tyler Gorda	2016	PhD	CU Physics	
Erika Zetterlund	2018	PhD	CU APS	
Javier Orjuela Koop	2018	PhD	CU Physics	
Jhett Bordwell	2019	PhD	CU APS	research advisor
Kurt Hill	2020	PhD	CU Physics	
Evan Anders	2020	PhD	CU APS	research advisor
Avery Schiff	2020	PhD	CU APS	
Ryan Orvedahl	2020	PhD	CU APS	
Daniel Everding	2020	PhD	CU APS	

## Outreach

Interviewed for A View from Earth Podcast, “Episode 6: The Sun is a mass of incandescent gas”, Fiske Planetarium, Jul 2020

Interviewed for Titanium Physicists Podcast, “Episode 84: Super stars look like zebras, with Ryan North”, Jan 2020

Substantial collaboration on “Solar Superstorms” planetarium show, Fiske Planetarium, University of Colorado, 2014–2015.

Substantial collaboration on “Journey to the Stars” planetarium show, Hayden Planetarium, American Museum of Natural History. 2 min screen time (8% of show) in final cut (2009)

Author of content for Science on a Sphere (2007–2012)

Author/lecturer of modern “Birth of Stars and Planets” planetarium show, Fiske Planetarium, U. Colorado. Used for astronomy classes and public shows. 10+ presentations, 30–200 attendees/show (2006–present)

## Experience acquiring external resources

Since arriving at CU Boulder as a faculty member in 2014, I have brought in approximately \$1.5M in federally supported grants as PI. I am Co-I on approximately \$2.9M in federally supported grants where the PI is a CU faculty member, and I am sole CU Co-I on \$653k (CU portion) in federally supported grants where the PI is at an external institution. I am PI on significant NASA supported computing allocations ( $\sim 30$ M cpu hour/yr), and we have been members of major DOE supercomputing awards ( $\sim 0.5$ B cpu hour/yr).

### Awarded Grants

Co-I NASA Heliophysics Theory, Modelling and Simulation

*Magneto-Rotational Instability in the Sun?*

*Global radiation-MHD simulations of the Near-Surface Shear Layer*

(PI: Lecoanet, Northwestern, 2020–2023, \$1,539,178; Brown portion \$653,236)

Co-I NASA Heliophysics Living With a Star Focused Science Team

*Processes shaping the solar meridional circulation*

(PI: Featherstone, CU, 2020–2023, \$885,390)

P-I NASA Earth and Space Science Fellowship

*Fundamental studies into the solar convective conundrum: Do giant cells exist?*

(Student PI: Anders, CU, 2018–2020, \$90,000)

P-I NASA Solar System Workings

*Atmospheric waves in giant planets: energy and chemical transport*

(2018–2021, \$442,774)

Co-I NASA Heliophysics Supporting Research grant

*Seeking the deep origins of sunspots*

(PI: Toomre, CU, 2018–2021, \$742,405)

Co-I NSF Astronomy & Astrophysics Grant

*Resolving the source of the solar acoustic oscillations: Preparing for the DKIST era*

(PI: Rast, CU, 2016–2019, \$651,725)

P-I NASA Living With a Star Focused Science Team

*Stellar insights into solar magnetism:*

*Exploring fundamental dynamo physics across the lower main sequence*

(2015–2020, \$960,132)

Co-I NASA Astrophysical Theory Program grant

*Tiny stars, strong fields: exploring the origin of intense magnetism in M stars*

(PI: Toomre, CU, 2015–2020, \$591,563)

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Prior to CU Boulder

Co-I NASA Heliophysics Theory Program grant

*Dynamic Origins of Cyclic Solar Activity*

(PI: Toomre, CU, 2010–2015, \$1,410,067)

P-I NSF Astronomy and Astrophysics Postdoctoral Fellowship

*Magnetism in the habitable zone: simulations of dynamo activity in lower-mass stars*

(2009–2013, \$249,000)

P-I NASA Graduate Student Research Program

*Role of Deep Solar Convection in Evolving Magnetism and SSW*

(Student PI: Brown, 2006–2009, \$72,000)

## CU Boulder internal grants

Co-I CU Seed Grant

*Exploring doubly-diffusive turbulence in extreme environments*

(PI Keith Julien, Applied Math, \$50,000)

Co-I CU IMPART Grant

*Conversations in equity and inclusion in Astronomy and Astrophysics*

(PIs Alicia Aarnio & Zach Berta-Thompson, 2018–2019, \$4,000)

Co-I CU IMPART Grant

*Conversations in equity and inclusion in Astronomy and Astrophysics*

(PI Alicia Aarnio, 2017–2018, \$4,000)

Co-I CU Diversity & Excellence Grant

*Inclusive, culturally aware mentoring:*

*the most important thing we don't know how to do for our students*

(PI Alicia Aarnio, 2017–2018, \$3,000)

P-I CU ASSETT Development Award

*Developing digital assets for teaching general astronomy courses at Fiske planetarium.*

(2015-2016, \$4000)

## Other Competitive Resources

P-I awarded NASA HEC Planetary supercomputing allocation (2018–present, 10M cpu-hours/year)

P-I awarded NASA HEC Heliophysics supercomputing allocation (2015–present, 22M cpu-hours/year)

P-I awarded CU Research Computing supercomputing allocation (2015–present, 4M cpu-hours/year)

Co-I awarded DOE INCITE supercomputing allocation (2014–2017, ~ 250M cpu-hours/year)

Co-I awarded NASA supercomputing allocation (2010–2017, ~ 60M cpu-hours/year)

Co-I awarded NSF Teragrid supercomputing allocation (2010–2013, ~ 14M cpu-hours/year)

Co-I massive star magnetic field program, Apache Point Observatory (6 half-nights)

P-I stellar flare program on South African Large Telescope (SALT/RSS, ~ 60 hrs over 3 seasons)

Co-I stellar differential rotation program on Center for High Angular Resolution Astronomy interferometer (CHARA/VEGA)

## Supercomputing experience

NASA resource *Pleiades* at Ames (2011–present)

CU Boulder resource *Summit* at CU (2016–present)

CU Boulder resource *Janus* at CU (2008–2016)

NSF Teragrid resource *Kraken* at NICS (2008–2014)

NSF Teragrid resource *Stampede* at TACC (2013–2014)

NSF Teragrid resource *Ranger* at TACC (2008–2013)

NASA resource *Columbia* at Ames (2005–2013)

NSF Teragrid resource *Bigben* at PSC (2005-2010)

NSF Teragrid resource *Blue Gene/L* at SDSC (2004–2009)

NSF Teragrid resource *Datastar* at SDSC (2004–2008)

NSF Teragrid resource *Lemieux* at PSC (2003–2006)

## Service

Core member development team, Dedalus open source community code ([dedalus-project.org](http://dedalus-project.org))

Director and **Search Committee Chair** of George Ellery Hale Postdoctoral Fellowship in Solar and Space Physics program within APS department at CU Boulder (2014–present)

**Chair** of Graduate Admissions Committee at CU Boulder (2017, 2021)

Question author and grader APS department Comps Exam (2014–2020)

Faculty member of Graduate Admissions Committee at CU Boulder (2014–2019, 2021)

Faculty member of Social and Welcoming Committee (2020, 2021)

Faculty member of Sommers-Bausch Observatory Oversight Committee at CU Boulder (2016–2017)

Faculty member of Fiske Planetarium Oversight Committee at CU Boulder (2014–2017)

Member of American Astronomical Society Employment Committee (2013–2018)

Member of Computational Infrastructure for Geodynamics: Geodynamo working group (2013–2017)

Theory group leader, Bcool stellar magnetism collaboration (2012–2016)

Lead author, 1 white paper for *Helio2010: A Decadal Strategy for Solar and Space Physics*

Contributing author, 2 white papers for *Helio2050: A Decadal Strategy for Solar and Space Physics*

Contributing author, 1 white paper for *Astro2020: Decadal Survey on Astronomy and Astrophysics*

Contributing author, 1 white paper for *NASA: Best Practices for Future Open Code Policy*

Contributing author, 2 white papers for *Helio2010: A Decadal Strategy for Solar and Space Physics*

Contributing author, 1 white paper for *Astro2010: The Astronomy and Astrophysics Decadal Survey*

Contributing scientist on the [VAPOR project](#) for volume visualization of large datasets (2008–2012)

Referee, *Journal of Fluid Mechanics* (2020–present)

Referee, *Living Reviews in Solar Physics* (2014–present)

Referee, *Astronomy & Astrophysics* (2011–present)

Referee, *Astrophysical Journal* (2010–present)

Referee, *Geophysical and Astrophysical Fluid Dynamics* (2008–present)

Referee, *Monthly Notices of the Royal Astronomical Society* (2012–present)

NSF and NASA grant reviewer

## Awards

2018 University of Colorado Marinus Smith Award

2017 University of Colorado Postdoctoral Mentor, honorable mention

\_\_\_\_\_ Prior to CU Boulder \_\_\_\_\_

2009–2013 NSF AAPF fellowship

2006–2009 NASA GSRP fellowship

2006 University of Colorado departmental teaching assistant award

2005 University of Colorado departmental teaching assistant award

## Professional Organizations

2020 – present American Geophysical Union

2014 – present American Physical Society, Division Fluid Dynamics

2003 – present American Astronomical Society, Solar Physics Division



# Publications

## Ph.D. thesis

*Convection and dynamo action in rapidly rotating suns*, 2009, Advisor: Juri Toomre

## Open Source Community Codes

*Dedalus: a flexible framework for spectrally solving differential equations*

Burns, K. J., Vasil, G. M., Oishi, J. S., Lecoanet, D. & **Brown, B. P.**,

<http://dedalus-project.org/> (and on github, & Astronomy Source Code Library)

more than 76 refereed papers use this code, and see **Burns et al (2020)**

## Journal articles

h-index: 26

citations: 2212 (from [scholar.google.com](https://scholar.google.com))

markings: \*\*Papers led by students who I mentored, [students I mentored](#) and [postdocs I mentored](#).

43. *Single-hemisphere dynamos in M-dwarf stars*,  
**Brown, B P**, Oishi, J S, Vasil, G M, Lecoanet, D, & Burns, K J, 2020, *ApJ*, 902(1), L3
42. \*\**Convective dynamics with mixed temperature boundary conditions: why thermal relaxation matters and how to accelerate it*,  
[Anders, E H](#), Vasil, G M, **Brown, B P**, & [Korre, L](#), 2020, *Physical Review Fluids*, 5(8), 083501,
41. *Dedalus: A flexible framework for numerical simulations with spectral methods*,  
Burns, K J, Vasil, G M, Oishi, J S, Lecoanet, D, & **Brown, B P**, 2020, *Physical Review Research*, 2(2), 023068 (**38 citations**)
40. *The magnetorotational instability prefers three dimensions*,  
Oishi, J S, Vasil, G M, Baxter, M, Swan, A, Burns, K J, Lecoanet, D, & **Brown, B P**, 2020, *Proceedings of the Royal Society A*, 476(2233), 20190622
39. \*\**Entropy Rain: dilution and compression of thermals in stratified domains*,  
[Anders, E H](#), Lecoanet, D, & **Brown, B P**, 2019, *ApJ*, 884(1), 65
38. *Breezing through the space environment of Barnard's Star b*,  
Alvarado-Gómez, J D, Garraffo, C, Drake, J J, **Brown, B P**, Oishi, J S, Moschou, S P, & Cohen, O, 2019, *ApJ*, 875(2), L12
37. *The "Sphered Cube": A new method for the solution of partial differential equations in cubical geometry*,  
Burns, K J, Lecoanet, D, Vasil, G M, Oishi, J S, & **Brown, B P**, 2019, *arXiv e-prints*, p. arXiv:1903.12642
36. *Tensor calculus in spherical coordinates using jacobi polynomials. part-I: Mathematical analysis and derivations*,  
Vasil, G M, Lecoanet, D, Burns, K J, Oishi, J S, & **Brown, B P**, 2019, *Journal of Computational Physics: X*, 3, 100013
35. *Tensor calculus in spherical coordinates using jacobi polynomials. part-II: Implementation and examples*,  
Lecoanet, D, Vasil, G M, Burns, K J, **Brown, B P**, & Oishi, J S, 2019, *Journal of Computational Physics: X*, 3, 100012
34. \*\**Predicting the Rossby number in convective experiments*  
[Anders, E. H.](#), [Manduca, C. M.](#), **Brown, B. P.**, Oishi, J. S., & Vasil, G. M., 2019, *ApJ*, 872, 138

33. **\*\*Accelerated evolution of convective simulations**  
[Anders, E. H.](#), **Brown, B. P.**, & Oishi, J. S. 2018, *Physical Review Fluids*, 3(8), 083502
32. **\*\*Convective Dynamics and Disequilibrium Chemistry in the Atmospheres of Giant Planets and Brown Dwarfs**  
[Bordwell, B.](#), **Brown, B P.**, & Oishi, J S, 2018, *ApJ*, 854, 8
31. **\*\*Convective heat transport in stratified atmospheres at low and high Mach number**  
[Anders, E H](#) & **Brown, B P**, 2017, *Physical Review Fluids*, 2(8), 083501
30. *On Differential Rotation and Overshooting in Solar-like Stars*  
 Brun, A S, Strugarek, A, Varela, J, Matt, S P, Augustson, K C, Emeriau, C, DoCao, O L, **Brown, B**, & Toomre, J, 2017, *ApJ*, 836, 192 (**46 citations**)
29. *Tensor calculus in polar coordinates using Jacobi polynomials*  
 Vasil, G M, Burns, K J, Lecoanet, D, Olver, S, **Brown, B P**, & Oishi, J S, 2016, *Journal of Computational Physics*, 325, 53–73 (**21 citations**)
28. *Turbulent Chemical Diffusion in Convectively Bounded Carbon Flames*  
 Lecoanet, D, Schwab, J, Quataert, E, Bildsten, L, Timmes, F X, Burns, K J, Vasil, G M, Oishi, J S, & **Brown, B P**, 2016, *ApJ*, 832, 71 (**30 citations**)
27. *Performance benchmarks for a next generation numerical dynamo model*  
 Matsui, H, Heien, E, Aubert, J, Aurnou, J M, Avery, M, **Brown, B**, Buffett, B A, Busse, F, Christensen, U R, Davies, C J, Featherstone, N, Gastine, T, Glatzmaier, G A, Gubbins, D, Guermond, J-L, Hayashi, Y-Y, Hollerbach, R, Hwang, L J, Jackson, A, Jones, C A, Jiang, W, Kellogg, L H, Kuang, W, Landeau, M, Marti, P, Olson, P, Ribeiro, A, Sasaki, Y, Schaeffer, N, Simitev, R D, Sheyko, A, Silva, L, Stanley, S, Takahashi, F, Takehiro, S-i, Wicht, J, & Willis, A P, 2016, *Geochemistry, Geophysics, Geosystems*, 17, 1586–1607 (**49 citations**)
26. *M Dwarf Flare Continuum Variations on One-second Timescales: Calibrating and Modeling of UL-TRACAM Flare Color Indices*  
 Kowalski, A F, Mathioudakis, M, Hawley, S L, Wisniewski, J P, Dhillon, V S, Marsh, T R, Hilton, E J, & **Brown, B P**, 2016, *ApJ*, 820, 95 (**25 citations**)
25. *A validated non-linear Kelvin-Helmholtz benchmark for numerical hydrodynamics*  
 Lecoanet, D, McCourt, M, Quataert, E, Burns, K J, Vasil, G M, Oishi, J S, **Brown, B P**, Stone, J M, & O’Leary, R M, 2016, *MNRAS*, 455, 4274–4288 (**40 citations**)
24. *Numerical simulations of internal wave generation by convection in water*  
 Lecoanet, D, Le Bars, M, Burns, K J, Vasil, G M, **Brown, B P**, Quataert, E, & Oishi, J S, 2015, *Phys. Rev. E*, 91, 063016:1–10 (**30 citations**)

23. *Angular momentum transport via internal gravity waves in evolving stars*  
Fuller, J, Lecoanet, D, Cantiello, M, & **Brown, B P**, 2014, *ApJ*, 796, 17:1–12 (**79 citations**)
22. *Properties of 42 solar-type Kepler targets from the Asteroseismic Modeling Portal*  
Metcalf, T. S., Creevey, O. L., Dogan, G., et al. (including **Brown, B P**), 2014, *ApJS*, 214, 27:1–13 (**120 citations**)
21. *\*\* Conduction in low Mach number flows: Part I Linear and weakly nonlinear regimes*  
Lecoanet, D, **Brown, B P**, Zweibel, E G, Burns, K J, Oishi, J S, & Vasil, G M, 2014, *ApJ*, 797, 94:1–16 (**21 citations**)
20. *Buoyant magnetic loops generated by global convective dynamo action*  
Nelson, N J, **Brown, B P**, Brun, A S, Miesch, M S, & Toomre, J, 2014, *Sol. Phys.*, 289, 441–458 (**57 citations**)
19. *Energy conservation and gravity waves in sound-proof treatments of stellar interiors: Part II Lagrangian constrained analysis*  
Vasil, G M, Lecoanet, D, **Brown, B P**, Wood, T S, & Zweibel, E G, 2013, *ApJ*, 773, 169:1–23 (**43 citations**)
18. *Magnetic wreaths and cycles in convective dynamos*  
Nelson, N J, **Brown, B P**, Brun, A S, Miesch, M S, & Toomre, J, 2013a, *ApJ*, 762, 73:1–20 (**133 citations**)
17. *Magnetic activity cycles in the exoplanet host star epsilon Eridani*  
Metcalf, T S, Buccino, A P, **Brown, B P**, Mathur, S, Soderblom, D R, Henry, T J, Mauas, P J D, Petrucci, R, Hall, J C, & Basu, S, 2013, *ApJ*, 763, L26:1–6 (**72 citations**)
16. *Energy conservation and gravity waves in sound-proof treatments of stellar interiors: Part I anelastic approximations*  
**Brown, B P**, Vasil, G M, & Zweibel, E G, 2012, *ApJ*, 756, 109:1–20 (**44 citations**)
15. *Convection and differential rotation in F-type stars*  
Augustson, K C, **Brown, B P**, Brun, A S, Miesch, M S, & Toomre, J, 2012, *ApJ*, 756, 169:1–23 (**44 citations**)
14. *Role of large-scale velocity fluctuations in a two-vortex kinematic dynamo*  
Kaplan, E J, **Brown, B P**, Rahbarnia, K, & Forest, C B, 2012, *Phys. Rev. E*, 85(6), 066315:1–9 (**8 citations**)
13. *Direct observation of the turbulent emf and transport of magnetic field in a liquid sodium experiment*  
Rahbarnia, K, **Brown, B P**, Clark, M M, Kaplan, E J, Nornberg, M D, Rasmus, A M, Zane Taylor, N, Forest, C B, Jenko, F, Limone, A, Pinton, J-F, Plihon, N, & Verhille, G, 2012, *ApJ*, 759, 80:1–6 (**24 citations**)
12. *Optimized boundary driven flows for dynamos in a sphere*  
Khalzov, I V, **Brown, B P**, Cooper, C M, Weisberh, D B, & Forest, C B, 2012a, *Physics of Plasmas*, 19(11), 112106:1–11 (**12 citations**)
11. *Resistive and ferritic-wall plasma dynamos in a sphere*  
Khalzov, I V, **Brown, B P**, Kaplan, E J, Katz, N, Paz-Soldan, C, Rahbarnia, K, Spence, E J, & Forest, C B, 2012b, *Physics of Plasmas*, 19(10), 104501:1–4 (**12 citations**)
10. *Modeling the Parker instability in a rotating plasma screw pinch*  
Khalzov, I V, **Brown, B P**, Katz, N, & Forest, C B, 2012c, *Physics of Plasmas*, 19(2), 022107:1–10

9. *Convective Babcock-Leighton dynamo models*  
Miesch, M S & **Brown, B P**, 2012, *ApJ*, 746, L26:1–5 (**14 citations**)
8. *Convection and differential rotation properties of G and K stars computed with the ASH code*  
Matt, S P, Do Cao, O, **Brown, B P**, & Brun, A S, 2011, *Astronomische Nachrichten*, 332, 897–906 (**38 citations**)
7. *Buoyant magnetic loops in a global dynamo simulation of a young sun*  
Nelson, N J, **Brown, B P**, Brun, A S, Miesch, M S, & Toomre, J, 2011, *ApJ*, 739, L38:1–5 (**53 citations**)
6. *Magnetic cycles in a convective dynamo simulation of a young solar-type star*  
**Brown, B P**, Miesch, M S, Browning, M K, Brun, A S, & Toomre, J, 2011, *ApJ*, 731, 69:1–19 (**170 citations**)
5. *Numerical simulation of laminar plasma dynamos in a cylindrical von Kármán flow*  
Khalzov, I V, **Brown, B P**, Ebrahimi, F, Schnack, D D, & Forest, C B, 2011, *Physics of Plasmas*, 18(3), 032110:1–9 (**9 citations**)
4. *Persistent magnetic wreaths in a rapidly rotating sun*  
**Brown, B P**, Browning, M K, Brun, A S, Miesch, M S, & Toomre, J, 2010, *ApJ*, 711, 424–438 (**192 citations**)
3. *Exploring the  $P_{cyc}$  vs.  $P_{rot}$  relation with flux transport dynamo models of solar-like stars*  
Jouve, L, **Brown, B P**, & Brun, A S, 2010, *A&A*, 509, A32:1–11 (**74 citations**)
2. *Rapidly rotating suns and active nests of convection*  
**Brown, B P**, Browning, M K, Brun, A S, Miesch, M S, & Toomre, J, 2008, *ApJ*, 689, 1354–1372 (**129 citations**)
1. *Rapid rotation, active nests of convection and global-scale flows in solar-like stars*  
**Brown, B P**, Browning, M K, Brun, A S, Miesch, M S, & Toomre, J, 2007, *Astron. Nachr.*, 328, 1002–1005

## Whitepapers

8. *Solar Magnetism and Structure from the Poles*, Newmark, J, Hoeksema, J T, Featherstone, N, Vourlidas, A, McIntosh, S, Gibson, S, Hassler, D, Dikpati, M, & **Brown, B P**, 2020, *Heliophysics 2050*
7. *The Science Case for a  $4\pi$  Perspective: A Polar/Global View for Understanding the Solar Cycle*, Hoeksema, J T, Basu, S, Braun, D, **Brown, B P**, Dikpati, M, Featherstone, N, Gibson, S, Hassler, D, Komm, R, Newmark, J, Pevtsov, A A, Vourlidas, A, & Zhao, J, 2020, *Heliophysics 2050*
6. *It's Time to Eliminate the GRE and PGRE in All Astronomy & Astrophysics PhD Programs: Motivation, Implementation and Outcomes*, Burgasser, A, Aarnio, A, Abazajian, K N, Agüeros, M, Barranco, J A, Berta-Thompson, Z K, **Brown, B P**, Casey, C, Charbonneau, D, Coble, K, Donahue, M, Gallagher, S, Greene, J, Horst, S, Konopacky, Q, Miller, C, Monkiewicz, J, Posselt, J, Ramirez-Ruiz, E, Rauscher, E, Redfield, S, Rudolph, A L, Sandstrom, K, & Venkatesan, A, 2019, BAAS, Vol. 51, p. 38
5. *Perspectives on Reproducibility and Sustainability of Open-Source Scientific Software from Seven Years of the Dedalus Project*, Oishi, J S, **Brown, B P**, Burns, K J, Lecoanet, D, & Vasil, G M, 2018, ArXiv e-prints 1801.08200, pp. 1–6

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Prior to CU Boulder

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4. *An experimental plasma dynamo program for investigations of fundamental processes in heliophysics*, **Brown, B**, Forest, C, Nornberg, M, Zweibel, E, Cattaneo, F & Cowley, S, 2010, *Helio2010: A Decadal Strategy for Solar and Space Physics*, pp. 1–6
3. *The importance of polar observations in understanding the solar dynamo*, Miesch, M, Rempel, M, Kosovichev, A, Sekii, T, Hara, H, Yokoyama, T, Brun, S, Tarbell, T, Appourchaux, T, **Brown, B P** & Toomre, J, 2010, *Helio2010: A Decadal Strategy for Solar and Space Physics*, pp. 1–7
2. *The solar magnetic dynamo and its role in the formation and evolution of the Sun, in the habitability of its planets, and in space weather around Earth*, Schrijver, K, Carpenter, K, Karovska, M, Ayres, T, Basri, G, **Brown, B**, Christensen-Dalsgaard, J, Dupree, A, Guinan, E, Jardine, M, Miesch, M, Pevtsov, A, Rempel, M, Scherrer, P, Solanki, S, Strassmeier, K & Walter, F, 2010, *Helio2010: A Decadal Strategy for Solar and Space Physics*, pp. 1–8
1. *Dynamos and magnetic fields of the Sun and other cool stars, and their role in the formation and evolution of stars and in the habitability of planets*, Schrijver, K, Carpenter, K, Karovska, M, Ayres, T, Basri, G, **Brown, B**, Christensen-Dalsgaard, J, Dupree, A, Guinan, E, Jardine, M, Miesch, M, Pevtsov, A, Rempel, M, Scherrer, P, Solanki, S, Strassmeier, K & Walter, F, 2009, *astro2010: The Astronomy and Astrophysics Decadal Survey*, pp. 262:1–8

## Conference proceedings

16. *Combined surface and volumetric occlusion shading*, Schott, M, Martin, T, Grosset, A, Brownlee, C, Holtt, T, **Brown, B P**, Smith, S, & Hansen, C, 2012, *Pacific Visualization Symposium (PacificVis), 2012 IEEE*, IEEE, pp. 169–176 (**9 citations**)
15. *New Era in 3-D Modeling of Convection and Magnetic Dynamos in Stellar Envelopes and Cores*, Toomre, J, Augustson, K C, **Brown, B P**, Browning, M K, Brun, A S, Featherstone, N A, & Miesch, M S, 2012, in Shibahashi, H, Takata, M, & Lynas-Gray, A E (eds), *Progress in Solar/Stellar Physics with Helio- and Asteroseismology*, Vol. 462 of *Astronomical Society of the Pacific Conference Series*, pp. 331–344
14. *Stellar magnetism*, Brownlee, C, **Brown, B P**, Clyne, J, Touati, C, Gaither, K, & Hansen, C, 2011, *Proceedings of the 2011 companion on High Performance Computing Networking, Storage and Analysis Companion*, ACM, pp. 151–152
13. *Global-scale Magnetism (and Cycles) in Dynamo Simulations of Stellar Convection Zones*, **Brown, B P**, Browning, M K, Brun, A S, Miesch, M S, & Toomre, J, 2011, in Johns-Krull, C, Browning, M K, & West, A A (eds), *16th Cambridge Workshop on Cool Stars, Stellar Systems, and the Sun*, Vol. 448 of *Astronomical Society of the Pacific Conference Series*, pp. 277–284
12. *Global magnetic cycles in rapidly rotating younger suns*, Nelson, N J, **Brown, B P**, Browning, M K, Brun, A S, Miesch, M S, & Toomre, J, 2011, *IAU Symposium*, Vol. 273 of *IAU Symposium*, pp. 272–275
11. *Magnetic Cycles and Meridional Circulation in Global Models of Solar Convection*, Miesch, M S, **Brown, B P**, Browning, M K, Brun, A S, & Toomre, J, 2011, in Brummell, N H, Brun, A S, Miesch, M S, & Ponty, Y (eds), *IAU Symposium*, Vol. 271 of *IAU Symposium*, pp. 261–269
10. *Global-scale wreath-building dynamos in stellar convection zones*, **Brown, B P**, Browning, M K, Brun, A S, Miesch, M S, & Toomre, J, 2011, in Brummell, N H, Brun, A S, Miesch, M S, & Ponty, Y (eds), *IAU Symposium*, Vol. 271 of *IAU Symposium*, pp. 78–85
9. *Laboratory dynamo experiments*, Nornberg, M D, Forest, C B, **Brown, B P**, Zweibel, E G, Wallace, J B, Clark, M, Spence, E J, Taylor, N Z, Kaplan, E J, & Rahbarnia, K, 2011, *2010 NASA Laboratory Astrophysics Workshop*, pp. C47:1–4
8. *Global-scale simulations of stellar convection and their observational predictions*, **Brown, B P**, 2011, in Creech-Eakman, M et al. (eds), *Resolving the future of astronomy with long-baseline interferometry*, *Astronomical Society of the Pacific Conference Series*, in press, pp. 1–9 [arXiv:1106.6075](https://arxiv.org/abs/1106.6075)
7. *Dynamos in stellar convection zones: of wreaths and cycles*, **Brown, B P**, 2010, in Appourchaux, T. et al. (eds), *GONG 2010/SOHO 24: A new era of seismology of the Sun and solar-like stars*, *J. Phys. Conf. Series*, pp. 1–10
6. *Three-dimensional simulations of solar and stellar dynamos: The influence of a tachocline*, Miesch, M S, Browning, M K, Brun, A S, Toomre, J, & **Brown, B P**, 2009, in M Dikpati, T Arentoft, I González Hernández, C Lindsey & F Hill (ed.), *GONG 2008/SOHO 21: Solar-stellar dynamos as revealed by helio- and asteroseismology*, Vol. 416 of *Astronomical Society of the Pacific Conference Series*, pp. 443–452
5. *Dynamo action and wreaths of magnetism in a younger sun*, **Brown, B P**, Browning, M K, Brun, A S, Miesch, M S & Toomre, J, 2009, in M Dikpati, T Arentoft, I González Hernández, C Lindsey & F Hill (ed.), *GONG 2008/SOHO 21: Solar-stellar dynamos as revealed by helio- and asteroseismology*, Vol. 416 of *Astronomical Society of the Pacific Conference Series*, pp. 369–374
4. *Strong dynamo action in rapidly rotating suns*, **Brown, B P**, Browning, M K, Brun, A S, Miesch, M S, Nelson, N J & Toomre, J, 2007, *American Institute of Physics Conference Series*, Vol. 948, pp. 271–278 (**37 citations**)

3. *Variations of solar subsurface weather in the vicinity of active regions*, **Brown, B P**, Haber, D A, Hindman, B W & Toomre, J, 2004, in D Danesy (ed.), *GONG 2004/SOHO 14: Helio- and asteroseismology: towards a golden future*, Vol. 559 of *ESA Special Publication*, pp. 345–348
2. *Differential rotation when the Sun spun faster*, **Brown, B P**, Browning, M K, Brun, A S & Toomre, J, 2004, in D Danesy (ed.), *GONG 2004/SOHO 14: Helio- and asteroseismology: towards a golden future*, Vol. 559 of *ESA Special Publication*, pp. 341–344
1. *Patterns of vorticity on the solar surface*, **Brown, B P** & Snodgrass, H B, 2003, in H Sawaya-Lacoste (ed.), *GONG+ 2002/SOHO 12: Local and global helioseismology: the present and future*, Vol. 517 of *ESA Special Publication*, pp. 109–113

## Invited scientific talks & Chaired sessions

### Chaired sessions

- Nov 2017, **Chaired session**, *D3: Astrophysical Fluid Dynamics, American Physical Society Division of Fluid Dynamics Meeting*, Denver, CO
- Nov 2016, **Chaired session**, *R10: Convection and Buoyancy Driven Flows: Planetary & Exoplanetary Dynamics, American Physical Society Division of Fluid Dynamics Meeting*, Portland, OR
- Jan 2013, **Chaired session**, *Star Evolution and Ages, American Astronomical Society Winter Meeting*, Long Beach, CA
- Jun 2012, **Chaired session**, *Star Clusters and the Milky Way, American Astronomical Society Summer Meeting*, Anchorage, AK
- Nov 2011, **Chaired session**, *Dynamo Mini Conference, American Physical Society: Division of Plasma Physics*, Salt Lake City, UT

### Interviews, Media & Press

- Jan 2020, *Podcast*: “Episode 84: Super Stars Look Like Zebras with Ryan North”, *Titanium Physicists Podcast*
- Fall 2019, “Waves of Change: KITP collaborators create a computational framework for fluid dynamics”, *KITP Newsletter; featured article*
- Nov 2019, “This Gene Technology Could Change the World. Its Maker Isn’t Sure It Should.”, *Vice magazine*

### Public Talks

- Nov 2019, *Public Talk*: “The Dedalus Project: open science and high performance science simulations using python”, *Astronomy on Tap*, Gunbarrel, CO
- Nov 2017, *Public Talk*: “Studying convection in stars like our Sun”, NASA Booth, *Supercomputing 2017*, Denver, CO
- May 2013, *Public Talk*: “Exploring our magnetic sun: convection and the solar dynamo”, UW Space Place, Madison, WI
- Sep 2012, *Public talk*: “Exploring our magnetic Sun: convection and the solar dynamo”, UW Space Place, Madison, WI
- Nov 2007, *Public talk*: “Global dynamo action in a younger sun,” NCAR & NASA booths *Supercomputing 2007*, Reno, NV

### Panels and Special Sessions

- Dec 2020, **Invited panelist, Special Session**, SH022 - Solar & Heliospheric Science from Out of the Ecliptic, “Hunting for giant cells at the solar poles”, *American Geophysical Union Fall Meeting*, virtual
- Jan 2019, **Invited Speaker, Special Session**, “The Dedalus project: open source science in astrophysics with examples in convection and stellar dynamos”, *American Astronomical Society Winter Meeting*, Seattle, WA
- Aug 2018, **Invited panelist**, “Advances in Computational Astrophysics and the Solar-Stellar-Planetary Connection”, *Cool Stars 20*, Boston, MA



## Colloquia

- Aug 2020, **Colloquium**: “The Sun, the stars and Jupiter Aswirl: fluid dynamics in stars and planets”, Department Astrophysical and Planetary Sciences, University of Colorado, Boulder
- Mar 2020, **Colloquium**: “The Dedalus project: Lessons learned in building a community code for solar physics” Institute Pascal Université Paris-Saclay, Orsay, France
- Mar 2019, **Colloquium**: “The Dedalus project: A flexible approach to solving PDEs, with applications in stellar astrophysics”, Institute for Applied Computational Science, Harvard, MA
- Oct 2016, **Colloquium**: “Deep solar convection: fundamental problems and progress”, High Altitude Observatory, Boulder, CO
- May 2015, **Colloquium**: “Dragons in the deep: dynamics and implications for the solar dynamo”, Institute for Astronomy, Kula, HI
- May 2015, **Colloquium**: “Magnetism in global solar and stellar dynamos”, Institute for Astronomy, Honolulu, HI
- Apr 2013, **Colloquium**: “Cyclic wreath-building dynamos in the Sun and sun-like stars”, University of Colorado, Boulder, CO
- Feb 2013, **Colloquium**: “Wreath-building stellar dynamos: how stars like our Sun get their spots?”, Columbia University, New York, NY
- Dec 2011, **Colloquium**: “Convective dynamos: how stars like the Sun get their spots”, University of Washington, Seattle, WA
- Mar 2010, **Colloquium**: “Cyclic wreath-building dynamos in simulations of solar-type stars,” South West Research Institute, Boulder, CO
- May 2009, **Colloquium**: “Dynamo action and wreaths of magnetism in rapidly rotating suns,” High Altitude Observatory, Boulder, CO
- Dec 2008, **Colloquium**: “Dynamos and magnetism in rapidly rotating suns,” University of Wisconsin, Madison, WI

## Invited Talks

- Oct 2019, “The Dedalus Project: High performance python and open science approaches in solar physics”, *PyHelio Conference*, Boulder, CO
- Sep 2018, “Overshoot in low-Mach number stellar convection”, *Geophysical Turbulence Program*, Boulder, CO
- Feb 2018, “Compressibility effects in convection”, *Natural Convection*, Princeton Center for Theoretical Sciences, Princeton, NJ
- Nov 2017, “Convective overshoot in the interiors of solar-type stars”, *American Physical Society Division of Fluid Dynamics Meeting*, Denver, CO
- Sep 2017, “Convective overshoot at the solar tachocline”, *Compressible Convection Conference*, Lyon, France
- Aug 2017, “Convective overshoot at the solar tachocline”, *American Astronomical Society Solar Physics Division Meeting*, Portland, OR
- Nov 2016, “Convective overshoot at stiffly stable interfaces”, *American Physical Society Division of Fluid Dynamics Meeting*, Portland, OR
- Aug 2016, “Convective overshoot: is there any under solar conditions”, *Geophysical Turbulence Program*, Boulder, CO
- Oct 2014, “Photospheric dynamics: Dragons in the deep”, DKIST Science Working Group, Maui, HI

Oct 2012, “Convective dynamos: field generation on the lower main-sequence”, *Second Bcool meeting*, Goettingen, Germany

Nov 2011, “Convective dynamos in solar-type stars,” *American Physical Society: Division of Plasma Physics Meeting*, Salt Lake City, UT

Oct 2011, “Convection in main-sequence stars,” *The Impact of Asteroseismology across Stellar Astrophysics*, KITP, Santa Barbara, CA

Oct 2011, “Wreath-building dynamos in solar-type stars: is this how stars like the Sun get their spots?”, Solar, Stellar and Planetary Sciences seminar, CfA, Boston, MA

Sep 2011, “Modelling Sun-like stars: cyclic convective dynamos,” *2011 SORCE Science meeting*, Sedona, AZ

Sep 2011, “Global-scale simulations of stellar convection and their observational predictions,” *The Future of Astronomy*, CIERA, Evanston, IL

Jun, 2011, “Global-scale magnetic fields from dynamo simulations of stellar convection,” *StarPol: Stellar Polarimetry from birth to death*, Madison, WI

May 2011, “Convection and differential rotation in solar-type stars,” *Differential Rotation in Stars*, Princeton, NJ

Apr 2011, “Simulations of global-scale dynamo action in the Sun and other stars,” *American Physical Society: April Meeting*, Orange, CA

Jul 2010, **Review talk**: “Dynamos in stellar convection zones: of wreaths and cycles,” *GONG 2010/SOHO 24: A new era of seismology of the Sun and solar-like stars*, Aix-en-provence, France

Apr 2010, “Mechanisms at work in global-scale wreath-building stellar dynamos,” *Special Topic Workshop on Imbalanced MHD*, Madison, WI

Feb 2010, “Simulations of the global dynamo in stars like the Sun,” Plasma physics seminar, University of Wisconsin, Madison, WI

Jan 2010, “Solar rotation II: from the Sun to the stars,” Lecture at CMPD/CMSO Winter School, UCLA, Los Angeles, CA

Dec 2009, “Convective flows in plasma experiments,” *Flow Driven Instabilities and Turbulence in High Beta Plasmas and Kick-off meeting for the Madison Plasma Dynamo Experiment*, Madison, WI

Jan 2009, “Wreaths of magnetism and other surprises in rapidly rotating suns,” Geophysics seminar, UCLA, Los Angeles, CA