

# Benjamin Brown

Department of Astrophysical and Planetary Sciences &  
Laboratory for Atmospheric and Space Physics  
University of Colorado  
Boulder, CO, 80302 USA

e-mail: [bpbrown@colorado.edu](mailto:bpbrown@colorado.edu)  
phone : (303) 735-2774  
fax : (303) 492-3822  
[http://arxiv.org/a/brown\\_b\\_1](http://arxiv.org/a/brown_b_1)  
and on Google Scholar

## 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. I explore stellar dynamo physics by studying the coupling of rotation, convection and magnetism through numerical simulations on massively-parallel supercomputers. This research is conducted using both the ASH code and the open-source Dedalus pseudospectral framework. My research focuses especially on 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 lead to improved treatments of gravity waves within anelastic and other low-mach number models. Stellar structure codes, including MESA and CESAM, are used in building the models of lower-mass stars. Results from the dynamo models are being connected with astrophysical observations and laboratory based dynamo experiments.

## Teaching and outreach experience

Advisor to three graduate students at U. Colorado: Evan Anders, Baylee Bordwell, Jessica Roberts (2014–present)

Taught graduate Mathematical Methods at U. Colorado, 10 students (Fall 2014)

Co-taught undergraduate class *AST 310: Stellar Interiors* with Ellen Zweibel at U. Wisconsin, 27 students, instructor of record (Fall 2012)

Created/taught graduate seminar *Being a Professional Scientist: Career Skills in Astronomy & Astrophysics*, U. Wisconsin, 15+ students (Spring 2011, Spring 2013)

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)

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 (SOS) (2007–present)

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

P-I funded NSF Astronomy and Astrophysics Postdoctoral Fellowship (2009–2013, \$249,000)  
P-I funded NASA GSRP graduate fellowship (2006–2009)  
P-I stellar flare program on South African Large Telescope (SALT/RSS, ~ 60 hrs over 3 seasons)  
Co-I funded NASA Heliophysics Theory Program grant (2010–present)  
Co-I awarded NSF Teragrid supercomputing allocation (2010–present, ~ 14M cpu-hours/year)  
Co-I awarded NASA supercomputing allocation (2010–present, ~ 20M cpu-hours/year)  
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)  
NSF Teragrid resource *Kraken* at NICS (2008–present)  
NSF Teragrid resource *Ranger* at TACC (2008–present)  
NASA resource *Columbia* at Ames (2005–present)  
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

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)  
Faculty member of Fiske Planetarium Oversight Committee at CU Boulder (2014–present)  
Faculty member of Graduate Admissions Committee at CU Boulder (2014–present)  
Member of American Astronomical Society Employment Committee (2013–present)  
Member of Computational Infrastructure for Geodynamics: Geodynamo working group (2013–present)  
Theory group leader, Bcool stellar magnetism collaboration (2012–present)  
Lead author, 1 white paper for *Helio2010: A Decadal Strategy for Solar and Space Physics*  
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 (<http://www.vapor.ucar.edu>) for volume visualization of large datasets (2008–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)

## Awards

NSF AAPF fellowship (2009–2013)  
NASA GSRP fellowship (2006–2009)  
University of Colorado departmental teaching assistant award (2005, 2006)

# Publications

## Ph.D. thesis

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

## Journal articles

25. *Internal wave generation by convection in water. Part 2. Numerical simulations*  
Lecoanet, D, Le Bars, M, Burns, K J, Vasil, G M, **Brown, B P** Quataert, E, & Oishi, J S, 2015, J. Fluid Mech. in press (*arXiv:1412.3109*)
24. *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
23. *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
22. *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. *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
20. *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
19. *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  
(**36 citations**)
18. *Buoyant magnetic loops generated by global convective dynamo action*  
Nelson, N J, **Brown, B P**, Brun, A S, Miesch, M S, & Toomre, J, 2013b, *Solar Physics*, pp. 1–18  
(**12 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
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 (**15 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  
(**16 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
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

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
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
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
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  
(14 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  
(23 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  
(76 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
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  
(103 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 (30 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  
(65 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

## 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
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 (**26 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

## Whitepapers

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

## Invited scientific talks & Chaired sessions

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

May 2013, *Public Talk*: “Exploring our magnetic sun: convection and the solar dynamo”, UW Space Place, Madison, WI

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

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

Sep 2012, *Public talk*: “Exploring our magnetic Sun: convection and the solar dynamo”, UW Space Place, Madison, WI

Dec 2011, **Colloquium**: “Convective dynamos: how stars like the Sun get their spots”, University of Washington, Seattle, WA

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

Mar 2010, **Colloquium**: “Cyclic wreath-building dynamos in simulations of solar-type stars,” South West Research Institute, Boulder, CO

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

May 2009, **Colloquium**: “Dynamo action and wreaths of magnetism in rapidly rotating suns,” High Altitude Observatory, Boulder, CO

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

Dec 2008, **Colloquium**: “Dynamos and magnetism in rapidly rotating suns,” University of Wisconsin, Madison, WI

Nov 2007, *Public talk*: “Global dynamo action in a younger sun,” NCAR & NASA booths *Supercomputing 2007*, Reno, NV

## References

**Prof. Ellen Zweibel**

Center for Magnetic Self-Organization in  
Laboratory & Astrophysical Plasmas and  
Department of Astronomy  
University of Wisconsin  
Phone: (608)-262-7921  
Email: zweibel@astro.wisc.edu

**Prof. Geoffrey Vasil**

Department of Applied Maths ?  
University of Sydney, Australia  
Phone:  
Email:

**Prof. Lars Bildsten**

Kavli Institute for Theoretical Physics  
University of California  
Phone: (805)-893-3979  
Email: bildsten@kitp.ucsb.edu

**Prof. Juri Toomre**

JILA and Dept. Astrophysical &  
Planetary Sciences  
University of Colorado  
Phone: (303)-492-7854  
Email: jtoomre@solarz.colorado.edu