

Douglas C. Braun

Northwest Research Associates, Inc.
Colorado Research Associates Division
3380 Mitchell Lane, Boulder CO 80301 USA
303 415-9701 x226 Fax: 303 415-9702
<http://www.cora.nwra.com/~dbraun>

Current Research Interests:

Solar physics and the study of the interior of the Sun. The interaction of acoustic waves with solar activity. Application and modeling of seismic imaging techniques of the solar interior. Establishing and refining local helioseismic analyses for probing the thermal, dynamical and magnetic properties of the solar convection zone and tachocline.

Education:

Ph.D., Astronomy, 1988, University of Hawaii at Manoa, Dissertation: "The Interaction of High-Degree p -mode Oscillations with Solar Active Regions"

M.S., Astronomy, 1985, University of Hawaii at Manoa

B.A. with Distinction, 1983, Physics and Astronomy, Swarthmore College

Professional Associations:

American Astronomical Society
Solar Physics Division, AAS
Global Oscillations Network Group (GONG)
International Astronomical Union
American Geophysical Union

Appointments:

Senior Research Scientist, Northwest Research Associates, 2004-present
Research Scientist, Northwest Research Associates, 2000-2004
Astronomer, Solar Physics Research Corp., 1993-2000
Long Term Visitor, High Altitude Observatory, 1996-1999
Visiting Astronomer, National Solar Observatory, 1993-1996
Assistant Astronomer, Institute for Astronomy, UH, 1990-1993
NRC Research Associate, NASA Goddard Space Flight Center, 1988-1989
Research Assistant, Institute for Astronomy, UH, 1984-1988
Teaching Assistant, Dept. Physics and Astronomy, U. of Hawaii, 1983-1984
Undergraduate Research Assistant, Sproul Observatory, 1980-1983

Committees:

Global Oscillations Network Group, Data Users Committee (appointed) 2001-present
American Astronomical Society, Solar Physics Division Committee (elected) 2004-2006

Refereed Papers:

- Braun, D. C., and Birch, A. C., 2007, "Surface-focused Seismic Holography of Sunspots: I. Observations," *Solar Phys.*, submitted
- Birch, A. C., Braun, D. C., and Hanasoge, S. M. 2007, "Surface-focused Seismic Holography of Sunspots: II. Expectations from Numerical Simulations Using Sound-speed Perturbations," *Solar Phys.*, submitted
- Braun, D. C., Birch, A. C., Benson, D., Stein, R. F., and Norlund, A. 2007, "Helioseismic Holography of Simulated Solar Convection and Prospects for the Detection of Small-Scale Subsurface Flows," *Atrophys J.* , **669**, 1395
- Schunker, H., Braun, D. C., and Cally, P. S. 2007 "Surface Magnetic Field Effects in Local Helioseismology," *Astron. Nach.*, **328**, 292
- Braun, D. C. and Birch, A. C. 2006, "Observed Frequency Variations of Solar p-Mode Travel Times as Evidence for Surface Effects in Sunspot Seismology," *Astrophys J.*, **647**, L187
- Crouch, A. D, Cally, P. S., Braun, D. C., and Desjardins, M. 2005, "Genetic magneto-helioseismology with Hankel analysis data," *Mon. Not. Roy. Astron. Soc.*, **363**, 1188
- Schunker, H., Braun, D. C., Cally, P. S., and Lindsey, C. 2005, "Local Helioseismology of Inclined Magnetic Fields and the Showerglass Effect," *Astrophys J.*, **621**, L149
- Lindsey, C. and Braun, D. C. 2005, "The Acoustic Showerglass I. Seismic Diagnostics of Photospheric Magnetic Fields," *Astrophys J.*, **620**, 1107
- Lindsey, C. and Braun, D. C. 2005, "The Acoustic Showerglass II. Imaging Active Region Subphotospheres," *Astrophys J.*, **620**, 1118
- Lindsey, C. and Braun, D. C. 2004, "Principles of Seismic Holography for Diagnostics of the Shallow Subphotosphere," *Astrophys J. Suppl.*, **155**, 209
- Cally, P. S., Crouch, A. D, and Braun, D. C. 2003, "Probing Sunspot Magnetic Fields with p-Mode Absorption and Phase Shift Data," *Mon. Not. Roy. Astron. Soc.*, **346**, 381
- Braun, D. C. and Lindsey, C. 2001, "Seismic Imaging of the Far Hemisphere of the Sun," *Astrophys. J.*, **560**, L189
- Donea, A.-C., Lindsey, C., and Braun, D. C. 2000, "Stochastic Seismic Emission from Acoustic Glories and the Quiet Sun," *Solar Phys.*, **192**, 321
- Braun, D. C. and Lindsey, C. 2000, "Phase-sensitive Holography of Solar Activity," *Solar Phys.*, **192**, 307
- Braun, D. C. and Lindsey, C. 2000, "Helioseismic Holography of Active-Region Subphotospheres," *Solar Phys.*, **192**, 285
- Lindsey, C. and Braun, D. C. 2000, "Basic Principles of Solar Acoustic Holography," *Solar Phys.*, **192**, 261
- Lindsey, C. and Braun, D. C. 2000, "Seismic Images of the Far Side of the Sun," *Science*, **287**, 1799
- Donea, A.-C., Braun D. C. and Lindsey, C. 1999, "Seismic Images of a Solar Flare," *Astrophys. J.*, **513**, L143
- Braun D. C. and Lindsey, C. 1999, "Helioseismic Images of an Active Region Complex," *Astrophys. J.*, **513**, L79

- Lindsey, C. and Braun, D. C. 1999, "Chromatic Holography of the Sunspot Acoustic Environment," *Astrophys. J.*, **510**, 494
- Lindsey, C. and Braun, D. C. 1998, "Acoustic Signatures of Subphotospheric Structure Underlying Sunspots," *Astrophys. J.*, **509**, L129
- Braun, D. C. and Fan, Y. 1998, "Helioseismic Measurements of the Subsurface Meridional Flow," *Astrophys. J.*, **508**, L105
- Braun, D. C., Lindsey, C., Fan, Y., and Fagan, M. 1998, "Seismic Holography of Solar Activity," *Astrophys. J.* **502**, 968
- Lindsey, C. and Braun, D. C. 1998, "The Acoustic Moat and Thermal Transport in the Neighborhoods of Sunspots," *Astrophys. J.*, **499**, L99
- Bogdan, T. J., Braun, D. C., Lites, B. W., and Thomas, J. H. 1998, "The Seismology of Sunspots: A Comparison of Time-Distance and Frequency-Wavenumber Methods," *Astrophys. J.*, **492**, 379
- Braun, D. C. 1997, "Time-Distance Sunspot Seismology with GONG Data," *Astrophys. J.*, **487**, 447
- Lindsey, C., and Braun, D. C. 1997, "Helioseismic Holography," *Astrophys. J.*, **485**, 895
- Lindsey, C., Braun, D. C., Jefferies, S. M., Woodard, M. F., Fan, Y., Gu, Y., and Redfield, S. 1996, "Doppler Acoustic Diagnostics of Subsurface Solar Magnetic Structure," *Astrophys. J.*, **470**, 636
- Fan, Y., Braun, D. C. and Chou, D. 1995, "Scattering of p -Modes by Sunspots. II. Calculations of Phase Shifts from a Phenomenological Model," *Astrophys. J.*, **451**, 877
- Braun, D. C. 1995, "Scattering of p -Modes by Sunspots. I. Observations," *Astrophys. J.*, **451**, 859
- Harrison, R. A., Carter, M. K., Clark, T. A., Lindsey, C., Jefferies, J. T., Sime, D. G., Watt, G., Roellig, T. L., Becklin, E. E., Naylor, D. A., Tompkins, G. J., and Braun, D. C., 1993, "An Active Solar Prominence in 1.3 mm Radiation," *Astron. & Astrophys.*, **274**, L9
- Braun, D. C., Lindsey, C., Fan, Y., and Jefferies, S. M. 1992, "Local Acoustic Diagnostics of the Solar Interior," *Astrophys. J.* **392**, 739
- Lindsey, C., Jefferies, J. T., Clark, T. A., Harrison, R. A., Carter, M. K., Watt, G., Becklin, E. E., Roellig, T. L., Braun, D. C., Naylor, D. A., and Tompkins, G. J. 1992, "Extreme-Infrared Brightness Profile of the Solar Chromosphere Obtained During the Total Eclipse of 1991," *Nature* **358** 308
- Braun, D. C., Duvall, T. L., Jr., LaBonte, B. J., Jefferies, S. M., Harvey, J. W., and Pomerantz, M. A. 1992, "Scattering of p -Modes by a Sunspot," *Astrophys. J.* **391**, L113
- Chou, D.-Y., LaBonte, B. J., Braun, D. C., and Duvall, T. L., Jr. 1991, "Power Spectra of Solar Convection," *Astrophys. J.* **372**, 314
- Braun, D. C., and Duvall, T. L., Jr. 1990, " p -Mode Absorption in the Giant Active Region of 10 March 1989," *Solar Physics* **129**, 83
- Lindsey, C. and Braun, D. C. 1990, "Helioseismic Imaging of Sunspots at Their Antipodes," *Solar Physics* **126**, 101

- Braun, D. C., LaBonte, B. J., and Duvall, T. L., Jr. 1990, "The Spatial Distribution of p -mode Absorption in Active Regions," *Astrophys. J.* **354**, 372
- Lindsey, C., Kopp, G., Becklin, E. E., Werner, M. W., Roellig, T. L., Orrall, F. Q., Braun, D. and Mickey, D. L. 1990, "Far Infrared Intensity Variations Caused by Five-Minute Oscillations," *Astrophys. J.* **350**, 475
- Braun, D. C., Duvall, T. L., Jr., and LaBonte, B. J. 1988, "The Absorption of High degree p -mode Oscillations In and Around Sunspots," *Astrophys. J.* **335**, 1015
- Braun, D. and Lindsey, C. 1987, "A Solar Chromosphere and Spicule Model Based on Far-Infrared Limb Observations," *Astrophys. J.*, **320**, 898
- Braun, D. C., Duvall, T. L., Jr., and LaBonte, B. J. 1987, "Acoustic Absorption by Sunspots," *Astrophys. J.* **319**, L27
- Lippincott, S. L., Braun, D. and McCarthy, D. W. 1983, "Astrometric and Infrared Speckle Analysis of the Visually Unresolved Binary BD +41 328," *Publ. Astron. Soc. Pac.* **95**, 271

Invited Conference Papers and Reviews:

- Braun, D.C. and Lindsey, C. 2003, "Helioseismic Imaging of the Farside and the Interior," in *Proceedings of SOHO 12 / GONG+ 2002. Local and Global Helioseismology: the Present and Future*, ed. H. Sawaya-Lacoste, **ESA SP-517**, (Noordwijk: ESA), 15
- Braun D. C. and Lindsey, C. 2001, "Seismic Holography of the Solar Interior and Far Side," in *Recent Insights into the Physics of the Sun and Heliosphere - Highlights from SOHO and Other Space Missions*, eds. P. Brekke, B. Fleck, and J. B. Gurman, ASP Conference Series **203**, 167
- Braun, D. C. and Lindsey, C. 2000, "Helioseismic Holography of Active-Region Subphotospheres," *Solar Phys.*, **192**, 285
- Lindsey, C. and Braun, D. C. 2000, "Basic Principles of Solar Acoustic Holography," *Solar Phys.*, **192**, 261
- Bogdan, T. J. and Braun, D. C. 1995, "Active Region Seismology," in *Fourth SOHO Workshop: Helioseismology*, eds. Hoeksema, J. T. et al., **ESA SP-376 Vol 1.**, (Noordwijk: ESA), 31
- Braun, D. C. 1995, "Sunspot Seismology: New Observations and Prospects," in *GONG 1994: Helio- and Astero-Seismology from the Earth and Space*, ed. Ulrich, T., Rhodes, E. & Däppen, W. ASP Conference Series **76**, (San Francisco: Astronomical Society of the Pacific), 250

Contributed Conference Papers:

- González Hernández, I., Hill, F., Lindsey, C., Braun, D., Scherrer, P., and Hanasoge, S. M. 2006, "Farside Helioseismic Holography: Recent Advances," In *Proceedings of SOHO 18/GONG 2006/HELAS I, Beyond the spherical Sun* ed Karen Fletcher, Michael Thompson, ESA SP-624 Published on CDROM, p.3.1
- Crouch, A. P., Cally, P. S., Charbonneau, P., Braun, D. C., and Desjardins, M. 2006, "The Role of MHD Mode Conversion in Sunspot Seismology," ASP Conf. Ser., **354**, 161
- Schunker, H., Braun, D.C., Lindsey, C., and Cally, P.S. 2006, "Behavior of Acoustic Waves in Sunspots," in ASP Conf. Ser., **354**, 244

- Malanushenko, A., Braun, D., Kholikov, S., Leibacher, J., and Lindsey, C. 2004 “Acoustic Holographic Studies of Solar Active Regions,” in *Multi-Wavelength Investigations of Solar Activity, IAU Symposium, No. 223*, ed A. V. Stepanov, E. E. Benevolenskaya and A. G. Kosovichev, (Cambridge, UK: Cambridge University Press), 283
- Braun, D.C., Birch, A., and Lindsey, C. 2004, “Local Helioseismology of Near-surface Flows,” in *Proceedings of SOHO 14 / GONG+ 2004. Helio- and Asteroseismology: Towards a Golden Future*, ed. D. Danesy, **ESA, SP-559**, 337
- Schunker, H., Braun, D.C., Lindsey, C., and Cally, P.S. 2004, “Local Helioseismology of Inclined Magnetic Fields and the Showerglass Effect,” in *Proceedings of SOHO 14 / GONG+ 2004. Helio- and Asteroseismology: Towards a Golden Future*, ed. D. Danesy, **ESA, SP-559**, 227
- Lindsey, C., and Braun, D.C. 2004, “The Penumbra Acoustic Anomaly,” in *Proceedings of SOHO 14 / GONG+ 2004. Helio- and Asteroseismology: Towards a Golden Future*, ed. D. Danesy, **ESA, SP-559**, 552
- Lindsey, C. Braun, D.C. 2003, “The Showerglass Effect in Seismic Diagnostics of Active Region Subphotospheres,” in *Proceedings of SOHO 12 / GONG+ 2002. Local and Global Helioseismology: the Present and Future*, ed. H. Sawaya-Lacoste, **ESA SP-517**, (Noordwijk: ESA), 23
- Barban, C., Howe, R., Hill, F., Komm, R. W., Leibacher, J., Toner, C., Bogart, R., Braun D., Haber, D., Hindman, B., and Lindsey, C. 2002, “MDI and GONG Inferences of the Changing Solar Interior,” in *From Solar Min to Max: Half a Solar Cycle with SOHO*, ed. A. Wilson, **ESA SP-508**, (Noordwijk: ESA), 55
- Braun D. C. and Lindsey, C. 2002, “Seismic Forecasting of Solar Activity,” in *Highlights of Astronomy, Vol 12 as presented at the XXIVth General Assembly of the IAU-2000 (Manchester, UK, 7-18 August 2000)* ed. H. Rickman, (San Francisco: Astronomical Society of the Pacific) 378
- Lindsey, C. and Braun, D. C. 1998, “Helioseismic Signatures of Subphotospheric Structure Beneath Active Regions,” in *Structure and Dynamics of the Interior of the Sun and Sun-like Stars*, eds. S. G. Korzennik and A. Wilson, **ESA SP-418**, (Noordwijk: ESA), 641
- Braun, D. C., Duvall, T. L., Jr., LaBonte, B. J., Jefferies, S. M., Harvey, J. W., and Pomerantz, M. A. 1993, “The p -Mode Scattering Properties of a Sunspot,” in *GONG 1992: Seismic Investigation of the Sun and Stars*, ed. T. Brown, (San Francisco: Astronomical Society of the Pacific), ASP Conference Series **42**, 77
- Lindsey, C., Braun, D. C., and Jefferies, S. M. 1993, “Local Helioseismology of Subsurface Structure,” in *GONG 1992: Seismic Investigation of the Sun and Stars*, ed. T. Brown, (San Francisco: Astronomical Society of the Pacific), ASP Conference Series **42**, 81
- Braun, D. C., Duvall, T. L., Jr., and Jefferies, S. M. 1990, “Observations of p -Mode Absorption in Active Regions,” in *Progress of Seismology of the Sun and Stars*, eds. Y. Osaki and H. Shibahasi, (Berlin: Springer), 181

Invited Conference Abstracts:

- Lindsey, C. and Braun, D. C. 2002, “Computational Seismic Holography of the Deep Interior and Far Surface of the Sun,” *Bul. Amer. Astron. Soc.*, **34**, 780
- Braun, D. C. 2001, “Progress in Helioseismic Holography,” *Eos. Trans. AGU* (**82**)**20**, S384

- Braun, D. C. 1999, "Comparative Results from Seismic Imaging and Hankel Analysis," *9th SOHO Workshop, Helioseismic Diagnostics of Solar Convection and Activity*, Stanford, CA 12-15 July, 1999
- Braun, D. C. 1999, "Local Helioseismology," *GONG '99 Workshop: Helioseismology at Intermediate and High Degree*, Tucson, AZ 22-24 March, 1999
- Braun, D. C. 1999, "New Results from Helioseismic Holography," *Bul. Amer. Astron. Soc.*, **31**, 882
- Braun, D. C. 1998, "Helioseismic Holography," *Eos Trans. AGU* **79(17)**, S277

Contributed Conference Abstracts:

- Braun, D., Birch, A. C., Benson, D., Stein, R. F., and Nordlund, A. 2007 "Helioseismic Holography of Simulated Solar Convection and Prospects for the Detection of Small-Scale Subsurface Flows," *Bul. Amer. Astron. Soc.*, **39**, 124
- Braun, D., Birch, A. C., and Hanasoge, S. M., 2007, "Sunspot Seismology: Testing Surface Effects with Numerical Simulations," *Bul. Amer. Astron. Soc.*, **39**, 125
- Gonzalez-Hernandez, I., Braun, D. C., Hanasoge, S. M., Hill, F., Lindsey, C. A. and Scherrer, P. H. 2006, "Farside Helioseismic Holography: Recent Advances," *Bul. Amer. Astron. Soc.*, **38**, 223
- Birch, A.C. and Braun, D.C. 2005, "Flow Inversions for Phase-Sensitive Helioseismic Holography," *Eos Trans. AGU* **(86)18**, 484
- Braun, D.C., Schunker, H., Lindsey, C., and Cally, P.S. 2005, "Towards Assessing, Understanding, and Correcting the Influence of Surface Magnetism in Local Helioseismology," *Eos Trans. AGU* **(86)18**, 483
- Haber, D.A., Featherstone, N.A., Braun, D.C., Hindman, B.W., and Bogart, R.S. 2005, "Comparison of Solar Subsurface Velocities Using Small-Scale Ring Analysis, Time-Distance and Holography," *Eos Trans. AGU* **(86)18**, 484
- Leibacher, J.W., Braun, D., González Hernández, I., Goodrich, J., Kholikov, S., Lindsey, C., Malanushenko, A., and Scherrer, P. 2005, "The GONG Farside Project," *Eos Trans. AGU* **(86)18**, 472
- Braun, D. C., Lindsey, C., and Birch, A. C. 2004, "Local Helioseismology of Solar Dynamics," *Bul. Amer. Astron. Soc.*, **36**, 757.
- Lindsey, C. and Braun, D. C. 2004, "The Acoustic Showerglass and Diagnostics of Active Region Subphotospheres," *Bul. Amer. Astron. Soc.*, **36**, 757
- Lindsey, C. and Braun, D.C. 2003, "Computational Seismic Holography of Active Region Subphotospheres," *Bul. Amer. Astron. Soc.*, **35**, 823
- Braun, D. C. and Lindsey, C., 2002, "The First Seismic Images of the Solar Interior and Far Side from the GONG+ Network," *Bul. Amer. Astron. Soc.*, **34**, 791
- Lindsey, C. and Braun, D. C. 2001, "Prospects for Helioseismic Holography in the Deep Solar Interior," *Eos Trans. AGU* **(82)20**, S384
- Lindsey, C. and Braun, D. C., 2000, "Prospects for Deep Interior Helioseismic Holography," *Recent Insights into the Physics of the Sun and Heliosphere: Highlights from SOHO and other Space Missions, IAU Symposium 203*, Manchester, England, August 2000
- Lindsey, C. and Braun, D. C., 2000, "Seismic Holography of the Deep Solar Interior," *Bul. Amer. Astron. Soc.*, **32**, 836

- Braun, D. C. and Lindsey, C., 2000, "Seismic Imaging of the Far Side and Interior of the Sun," *Bul. Amer. Astron. Soc.*, **32**, 831
- Donea, A.-C., Braun, D. C., and Lindsey, C. 1999, "Seismic Images of a Solar Flare," *9th SOHO Workshop, Helioseismic Diagnostics of Solar Convection and Activity*, Stanford, CA 12-15 July, 1999
- Braun, D. C. and Lindsey, C. 1999, "Seismic Imaging of Acoustic Moats around Active Regions," *9th SOHO Workshop, Helioseismic Diagnostics of Solar Convection and Activity*, Stanford, CA 12-15 July, 1999
- Donea, A.-C., Lindsey, C., Braun, D. C. 1999, "Stochastic Seismic Emission from Acoustic Glories and the Quiet Sun," *9th SOHO Workshop, Helioseismic Diagnostics of Solar Convection and Activity*, Stanford, CA 12-15 July, 1999
- Lindsey, C. and Braun, D. C. 1999, "Phase-Sensitive Seismic Holography of the Photospheres and Near Subphotospheres of Active Regions," *9th SOHO Workshop, Helioseismic Diagnostics of Solar Convection and Activity*, Stanford, CA 12-15 July, 1999
- Braun, D. C. and Lindsey, C. 1999, "Phase-Sensitive Holography of Acoustic Moats," *Bul. Amer. Astron. Soc.*, **31**, 913
- Lindsey, C. and Braun, D. C. 1999, "Helioseismic Holography," *GONG '99 Workshop: Helioseismology at Intermediate and High Degree*, Tucson, AZ 22-24 March, 1999
- Braun, D. C., Donea, A.-C., and Lindsey, C. 1999, "Local-helioseismic Investigation of Acoustic Glories and the Quiet Sun," *GONG '99 Workshop: Helioseismology at Intermediate and High Degree*, Tucson, AZ 22-24 March, 1999
- Lindsey, C. and Braun, D. C. 1998, "The Acoustic Moat and Thermal Transport in the Neighborhoods of Sunspots," *Eos Trans. AGU* **79(17)**, S277
- Braun, D. C. 1998, "Helioseismic Measurements of Meridional Circulation," *Eos Trans. AGU* **79(17)**, S277
- Lindsey, C., Braun, D. C., Jefferies, S. M., Fan, Y., Gu, Y., and Redfield, S. 1996, "Doppler Acoustic Diagnostics of Subsurface Solar Magnetic Structure," *Bul. Amer. Astron. Soc.*, **28**, 955
- Braun, D. C., Fan, Y., Lindsey, C., and Jefferies, S. M., 1996, "Helioseismic Measurements of Subsurface Outflows From Sunspots," *Bul. Amer. Astron. Soc.*, **28**, 937
- Braun, D. C. and Fan, Y. 1995, "Observations and Models of p -Mode Scattering by Sunspots," *Bul. Amer. Astron. Soc.*, **27**, 954
- Braun, D. C. 1994, "A Helioseismic Study of an Emerging Sunspot Group," *Eos Trans. AGU*. **75(16)**, 267
- Fan, Y. and Braun, D. C., 1994, "A Model of p -Mode Scattering by Sunspots," *Bul. Amer. Astron. Soc.*, **26**, 1377
- Lindsey, C., Braun, D. C., and Jefferies, S. M. 1993, "Prospects in Helioseismic Holography," *GONG Report Number 10: 1993 Annual GONG Meeting Abstracts*, 14
- Lindsey, C., Braun, D. C., Fan, Y., and Jefferies, S. M. 1992, "Prospects in Acoustic Holography of the Solar Interior," *Bul. Amer. Astron. Soc.*, **23**, 753
- Braun, D. C., Duvall, T. L., Jr., LaBonte, B. J., Jefferies, S. M., Harvey, J. W., and Pomerantz, M. A. 1992, "Scattering of p -Modes by a Sunspot," *Bul. Amer. Astron. Soc.*, **24**, 737

- Braun, D. C. and Lindsey, C., 1991, "An Acoustic Poynting Vector for Solar p -Mode Oscillations," *GONG Report Number 9: 1991 Annual GONG Meeting Abstracts*, 11.
- Braun, D. C. and Lindsey, C., 1990, "An Acoustic Poynting Vector for Solar p -Mode Oscillations," *Bul. Amer. Astron. Soc.*, **23**, 1049
- Braun, D. C., Duvall, T. L., Jr., and LaBonte, B. J., 1988, "Tomography of Active Regions," *Bul. Amer. Astron. Soc.*, **20**, 701
- Duvall, T. L., Jr., Harvey, J. W., Braun, D. C., LaBonte, B. J., and Pomerantz, M. A. 1988, "Sunspots as Sinks of p -Mode Wave Energy," *Bul. Amer. Astron. Soc.*, **19**, 934
- Braun, D. C., LaBonte, B. J., Duvall, T. L., Jr. 1988, "The Absorption of 5-minute Oscillations by Sunspots," *Bul. Amer. Astron. Soc.*, **19**, 936
- Braun, D. C. and LaBonte, B. J. 1985, "The Solar Irradiance from January to February 1981," *Bul. Amer. Astron. Soc.*, **17**, 756