

Bruce Partridge

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Personal

Born in Honolulu, Hawai'i, May 16, 1940.

Married to Dr. Jane Christina Widseth; two children, John and Carl.

Education

A.B., Princeton University, 1962

D. Phil., Oxford University, 1965

Employment

Lab instructor, Oxford University, 1963-65

Instructor, Princeton University, 1965-67

Assistant Professor, Princeton University, 1967-70

Associate Professor, Haverford College, 1970-1976

Full Professor, Haverford College, 1977-2009

Marshall Professor of Natural Sciences, Haverford College, 1982-2009

Dean of the College, Haverford College, 1982-1985

Provost, Haverford College, 1990-1995

Visiting Scholar, Inst. for Advanced Study, Princeton, 2005.

Research professor, emeritus, Haverford College, 2009-present

Fellowships and Awards

Rhodes Scholar, 1962-1965

Fulbright Scholar (Uruguay) 1970

Alfred P. Sloan Foundation Research Fellow, 1971-1976

Fulbright Scholar (Norway) 1979.

Christian and Mary Lindback award for distinguished teaching, 1981.

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Martin Foss Award (by Haverford students), 1981.

American Physical Society Award for Research in an Undergraduate Institution, 1988.

Guggenheim Fellowship, 1988-1989.

Haverford College Students' Council Award, 2004 and 2008.

NASA Group Achievement Awards (for work on *Planck*), 2014, 2015, 2016.

Richard Emmons Award for Excellence in Astronomy Education, 2017.

Royal Astronomical Society Groups Achievement Award in Astronomy to the *Planck* Team, 2018.

Gruber Prize in Cosmology to the *Planck* Team, 2018.

Giuseppe and Vanna Cocconi Prize of the European Physical Society to the *Planck* Team, 2019.

Society Memberships and Professional Activities

Member of the American Astronomical Society (A.A.S.), Astronomical Society of the Pacific (A.S.P.) and the International Astronomical Union (I.A.U.)

Committee Member, High Energy Astrophysics Division of A.A.S., 1969-1971.

Member, Evaluation Committee for National Research Council Postdoctoral Research Associateships, 1970-1972.

N.A.S.A. Consultant (Evaluation of Proposals for COBE, 1975; other reviews, 1994 and 1995).

Member, State Selection Committee for Rhodes Scholarships (West Virginia), 1975-1982; New Jersey (1993), Pennsylvania (1994-98; 2001; 2005-08).

Member, selection committee for the Marshall Scholarships to Great Britain, 1982-1991.

Member-at-large, Section Committee on Astronomy of the American Association for the Advancement of Science, 1976-1979.

NSF "Chautauqua" Lecturer, several occasions, 1972-1980.

User's Committee, National Radio Astronomy Observatory (NRAO), 1981-1983.

Gravitation, Cosmology and Cosmic Rays Panel of the National Research Council Physics Survey Committee, 1983-84 (see list of books below).

Chair, High Redshift Working Group of the Scientific Advisory Committee for the NRAO Millimeter Array, 1985.

Member, committee appointed by Educational Testing Service to write the Graduate Record Examination in Physics, 1986-1988.

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Member, Scientific Program Committee, Twelfth Conference of the International Society on General Relativity and Gravitation, 1988-1989; IAU Symposium 168, 1993-1994; IAU Symposium 175, 1994-1995; IAU Symposium 183, 1997; IAU Symposium 201, 2000; and several other international conferences.

Vice-president, Commission 47 (Cosmology) of the I.A.U, 1988-1991.

President, " " " , 1991-1994.

Councilor, American Astronomical Society, 1989-1992.

Member of visiting committees to University of Virginia, Princeton, the Center for Particle Astrophysics (Berkeley), the National Radio Astronomy Observatory, Haystack Observatory, IPAC at Caltech, Lafayette University, Vassar College, Dickinson College and Middlebury College.

Member, Advisory Committee for Mathematical and Physical Sciences, NSF, 1993-1996.

President, Division of Cosmology and Extragalactic Astronomy, IAU, 1994-1997.

Education Officer, American Astronomical Society, 1997-2003.

Member, Astronomy and Astrophysics Survey Committee (the “decadal study” in astronomy), 1998-2000.

Member, Portfolio Allocation Review Committee, NSF/AST, 1999.

Member, Distinguished Teacher Scholar advisory committee to NSF/DUE, 1999.

Member, Committee on Science and the Arts, the Franklin Institute, 1999-2002.

Member, Interagency Task Force on CMB Research, 2004-2005.

Bissell Lecturer, The Hill School, 2004.

Member, NRC Committee to Review and Evaluate NASA’s Precollege Education Program, 2006-07.

Member, Alpher Prize Selection Committee, 2006-2009.

Member, NRC Committee on NASA’s Suborbital Programs, 2008-2010.

Member, selection committee for DOE Early Career Grants, 2015.

Shapley Lecturer, various institutions including Union, Allegheny and Bates Colleges, 1998-present.

Member, Board of Directors, Astronomical Society of the Pacific, 2002-2008.

President, Astronomical Society of the Pacific, 2009-2011.

College Committees and Related Duties

Faculty Marshal, 2010 - 2017

Chair, Search Committee in Economics, 2007-08.

Chair, Committee on Admissions, 2004-07.

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Member, Steering Committee for Middle States Evaluation, 1997-1999.

Provost, 1990-1995.

Chair, Educational Policy Committee, 1989-1990 (member, ex officio of the same committee, 1990-1995 and 1982-1984).

Presidential Search Committee, 1987-1988.

Chair, Administrative Advisory Committee (our budget committee), 1986-1987; also member (then chair) of the same committee, 1976-1978.

Secretary, Haverford's chapter of Phi Beta Kappa, 1986-1988.

Ad Hoc "Aesthetics" Committee for the rehabilitation of two major buildings on campus (design decisions; selecting architects, etc.), 1987-1993.

Dean of the College, 1982-1985.

Member of Academic Council (Haverford's tenure and reappointment committee), 1990-1995, 1981-1985 and 1972-1975.

Member, Long-Range Planning Committees, 1997-1999, 1994-1995, 1983-1984 and 1979-1980.

Director, Minority Science Scholars Program , 1980-1982.

Member, Committee on Admissions Policy, 1975-1976; this was the group that recommended and planned for the admission of women to Haverford.

While at Princeton, I served as a freshman advisor and worked with the Admissions Office; I was also on the Governance Committee in 1968-1969, a Board-Faculty-Student committee which reordered the governance of the University.

I have not listed here some continuing but off and on duties such as service on search committees for faculty and administrators, assembling tenure and promotion cases and several terms of duty as department chair.

Research Interests

The cosmic microwave background radiation, especially its angular distribution and spectrum (see articles 7, 13, 42, 62, 75, 95, 102, 125, 138, 171, 200, 204, 218, 246 and 253 below).

Galaxy formation and the physical properties of newly-formed and starburst galaxies. See articles 7, 8, 29, 133, 147, 173, 229 and 270 below.

Cosmology, especially the question of the present mass and luminosity density of the Universe and star formation history (see articles 7, 10, 27, 131, 132, 146, and 147), and radio source counts (see articles 60, 67, 103, 154, 170, 223, 254, 258 and 275 below).

Radio astronomy: counts of radio sources (see articles 60, 67, 103, 154, 170 and 223 below), properties of extreme sources (see articles 115, 139, 153, 179, 205, 216 and 222 below),

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and the contamination of CMB images by radio sources (see 176, 178, 179, 205, 224, 260 and 279 below).

Astronomy education (see articles 148, 155, 159, 160, 161 and 164 below, as well as books 4 and 5 and websites 3-5 below).

In the past, I've also worked on optical pumping in gasses, pulsar timing, the interstellar medium and short time-scale phenomena in astronomy (e.g., searches for microwave pulses associated either with gravitational wave events or with supernovae).

Publications are listed separately.

Funding

Current Support

JPL subcontract for follow-up work on ESA's Planck mission (~\$35,000).

In the past, I have had NSF support continuously from 1976 to 2011 from the Astronomy Division, and grants from NSF/HER. My work on Planck for ~20 years NASA through a subcontract with JPL. I have also been supported by NATO, the Dudley Observatory, the AAS, NASA (HST Cycle 7) and the Thiel Foundation.

Observing time

In addition to numerous runs at the Very Large Array and (former) 11-meter telescope, I have made radio observations at Green Bank and the Argentine Radio Astronomy Institute, and optical observations at Kitt Peak (0.9 and 1.3 meter telescopes), Lick Observatory, the Wyoming Infrared Observatory, NASA's Infrared Telescope and the Hubble Space Telescope.

Teaching experience

In addition to advanced astronomy courses, in cosmology and radio astronomy I have taught physics courses at all levels here and at Princeton. I also enjoy teaching technical subjects to non-specialists; roughly 20% of the Haverford student body took one of the three astronomy survey courses I offered. Some years ago, I taught in Haverford's Freshman Seminar program, a writing-intensive seminar course for entering students.

I try to involve juniors and seniors in research; more than 30 of my refereed papers have student coauthors.

Former Students Now in Astronomy or Related Fields

Listed here are students who have done research with me as undergraduates, and have then gone on to scientific or technical careers. In roughly historical order, they are:

William Stoner (my only graduate student at Princeton, now in a medical technology firm)

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Jay Gallagher, Wisconsin

Steve Boughn, recently retired from Haverford

Paul Hanle, Philadelphia Science Museum

Steve Pravdo, JPL

Susan Ames, Radio Institute, Bonn

John Thorstensen, Dartmouth

George Lake, University of Zurich (deceased)

Michael Gregg, Univ. of California, Davis

Eric Feigelson, former Presidential Young Science Investigator at Penn State

Buddy Martin, University of Arizona “mirror lab”

Ann Wehrle, Caltech

Tom McGlynn, Space Telescope Science Institute

Jacqueline Hewitt, MIT

Alex Rudolph, Cal. Poly.

Jim Knoke, DigitalNet

Ian Dell'Antonio, Brown University

Hank Donnelly, Center for Naval Analysis

Ravi Sheth, Univ. of Pennsylvania

Liese Van Zee, Indiana University

Thomas Crawford, Seagate Inc.

Eric Richards, Talladega College

Elizabeth Rizza, New Mexico State

John Eppley, MIT (biophysics)

Andrew West, Boston University

Megan Roscioli Gralla, University of Arizona

Sarah Burke Spolar, JPL

Brook Henkel, St. Lawrence Univ. (German Dept.)

Kahdija El Bouchefry, AIMS, Univ. of Cape Town, South Africa

Tyler Evans, Swinburne Univ., Australia

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Shea Garrison-Kimmel, Cal Tech (postdoc)

Nick Vechik, science teacher, the Phelps School

Benjamin Walter, teacher, Jackson Classical Academy

Will Greer, Goldman Sachs

Gerrit Farren, senior at Haverford College

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Publications: All published papers to date are listed. A dagger is used to indicate those that may be more interesting, and an asterisk to indicate undergraduate coauthors.

1. (with G. B. Field) Stimulated Emission of the 3.04-cm Fine-Structure Line of Hydrogen in Diffuse Nebulae, *Astrophysical Journal*, Vol. **134**, 959 (1961).
2. The Carry-Over of Coherence in a Cycle of Optical Pumping in Helium; Proceedings AIP and APS Conference on Atomic Spectra and Radiation Processes, London (1965).
- †3. (with T. R. Carver) Monitoring Operators in Magnetic Resonance and Light Modulation, *American Journal of Physics*, Vol. **34**, No. 4, 339, April (1966).
4. (with G. W. Series) The Modulated Absorption of Light in an Optical Pumping Experiment in ^4He , *Proc. Phys. Soc.*, Vol. **88**, 969 (1966).
5. (with G. W. Series) The Transfer of Coherence by Collisions of ^3He Atoms, *Proc. Phys. Soc.*, Vol. **88**, 983 (1966).
6. (with G. B. Field and H. Sobel*) Effects of Absorption Spectra of Ices on the u.v. Extinction by Interstellar Grains, *Interstellar Grains*, NASA SP-140, 1967.
- †7. (with P. J. E. Peebles) Are Young Galaxies Visible?, *Astrophysical Journal*, Vol. **147**, No. 3, 868, March (1967).
8. (with P. J. E. Peebles) Are Young Galaxies Visible? II. *Astrophysical Journal*, Vol. **148**, 377, May (1967).
- †9. (with D. T. Wilkinson) Isotropy and Homogeneity of the Universe from Measurements of the Cosmic Microwave Background, *Physical Review Letters*, Vol. **18**, No. 14, 557, April (1967).
10. (with P. J. E. Peebles) Upper Limit on the Mean Mass Density Due to Galaxies, *Astrophysical Journal*, Vol. **148**, 713, June (1967).
11. Possible Population II Binary Stars, *Astronomical Journal*, Vol. **72**, No. 6, 713, August (1967).
12. (with D. T. Wilkinson) Large Scale Density Inhomogeneities in the Universe, *Nature*, Vol. **215**, No. 5102, 719, August (1967).
- †13. (with R. A. Stokes and D. T. Wilkinson) New Measurements of the Cosmic Microwave Background at $\lambda = 3.2$ cm and $\lambda = 1.58$ cm—Evidence in Support of a Blackbody Spectrum, *Physical Review Letters*, Vol. **19**, No. 20, 1199, November (1967).
- †14. The Primeval Fireball Today, *American Scientist*, Vol. **57**, p. 37, Spring (1969).
15. (with P. Encrenaz) Mean Free Paths of Cosmic Rays through a Far Infrared Radiation Field, *Astrophysical Letters*, Vol. **3**, p. 161 (1969).
- †16. (with P. E. Boynton, E. J. Groth and D. T. Wilkinson) Precision Measurement of the Frequency Decay of the Crab Nebula Pulsar, *Astrophysical Journal Letters*, Vol. **157**, L197, September (1969).

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17. (with M. G. Smith*) Can Discrete Sources Produce the Cosmic Microwave Radiation? *Astrophysical Journal*, Vol. **159**, 737, March (1970).
18. (with Remo Ruffini) Gravitational Waves and a Search for Associated Microwave Electromagnetic Radiation, Essay submitted to the Gravity Research Foundation (3rd prize 1970).
19. (with S. P. Boughn* and D. M. Fram) Isotropy of the Microwave Background at 8 mm Wavelength, *Astrophysical Journal*, Vol. **165**, 439, May (1971).
20. Search for Microwave Pulses Associated with Gravitational Radiation, *Physical Review Letters*, **26**, 912, 1971.
21. (with P. Horowitz *et al.*) Optical Time-of-arrival Measurements from the Crab Pulsar, *Astrophysical Journal Letters*, **166**, L91, 1971.
22. Timing of Optical Pulses from the Crab Nebula Pulsar, I.A.U. Symposium 46, 1971.
23. (with B. Nickerson*) The Density of Intergalactic Dust, *Astrophysical Journal*, **169**, 203, 1971.
24. (with G. T. Wrixon) A constraint on Astrophysical Sources of Gravity Waves, *Astrophysical Journal Letters*, **173**, L75, 1972.
25. (with P. Boynton *et al.*) Optical Timing of the Crab Pulsar, NP0532, *Astrophysical Journal*, **175**, 217, 1972.
26. (with P. Boynton) Fine-scale Anisotropy of the Microwave Background: An Upper Limit at $\lambda = 3.5$ mm, *Astrophysical Journal*, **181**, 243, 1973.
27. Absorber Theory of Radiation and the Future of the Universe, *Nature*, **244**, 263, 1973.
- †28. (with G. T. Wrixon *et al.*) Sensitive Search for Microwave Pulses from the Galactic Centre, *Nature*, **245**, 53, 1973.
- †29. A Search for Primeval Galaxies at High Redshifts, *Astrophysical Journal*, **192**, 241, 1974.
30. (with T. Delaney *et al.*) A Search for Isolated Microwave Pulses from the Perseus Cluster of Galaxies, *Astronomy and Astrophysics*, **36**, 83, 1974.
31. Large Scale Anisotropy of the Cosmic Microwave Background, in *I.A.U. Symposium 63, Confrontation of Cosmological Theories with Observational Data*, ed. M. S. Longair, Reidel and Co., 1974.
32. Pulse Astronomy, in *Neutron Stars, Black Holes and Binary X-Ray Sources*, ed. H. Gursky and R. Ruffini, Reidel and Co., 1975.
33. (with J. R. Thorstensen*) Can Collapsed Stars Close the Universe?, *Astrophysical Journal*, **200**, 527, 1975.
34. (with W. P. S. Meikle *et al.*) An Upper Limit to Microwave Pulse Emission at the Onset of a Supernova, *Astronomy and Astrophysics*, **46**, 477, 1976.

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35. A Review of Some Radio and Microwave Searches for Transient Phenomena, *Astrophysics and Space Sciences*, **42**, 69, 1976.
36. (with G. Lake*) Detection of Intergalactic Gas in Distant Rich Clusters, *Nature*, **270**, 502, 1977.
37. Observational Cosmology, in *Proceedings of the First Marcel Grossman Meeting on General Relativity* (R. Ruffini, ed.), North-Holland, 1978.
38. Upper Limit on the Microwave Pulsed Emission from Supernovae Explosions, *Astrophysics and Space Sciences*, **54**, 355, 1978.
39. Cosmological Anisotropies in the Microwave Background, in *Physics of the Expanding Universe*, M. Demianski, ed., Springer, Berlin, 1979.
40. Fluctuations in the Cosmic Microwave Background at Small Angular Scales, *Physics Scripta*, **21**, 624, 1980.
41. (with G. Sironi *et al.*) Anisotropies in the Intensity of the Cosmic Microwave Background, in *Proceedings of the Kyoto Meeting on Cosmic Rays*, 1979.
- †42. New Limits on Small-Scale Angular Fluctuations in the Cosmic Microwave Background, *Astrophysical Journal*, **235**, 681, 1980.
- †43. (with G. Lake*) Search for Ionized Gas in Clusters of Galaxies, *Astrophysical Journal*, **237**, 378, 1980.
44. (with H. M. Martin* and R. T. Rood) Interferometric Limits on Very Small Scale Fluctuations in the Cosmic Microwave Background, *Astrophysical Journal Letters*, **240**, L79, 1980.
45. Observational Cosmology: Recent Progress and Remaining Problems, *Problema del Cosmo*, p. 127, Enciclopedia Italiana, Rome, 1982.
46. The Evolution of Structure in the Universe, in *Cosmology and Particles*, XVI Rencontre de Moriond, J. Audouze *et al.* eds., Editions Frontières, Dreux, France, 1981.
- †47. (with G. Smoot *et al.*) Low-Frequency Measurement of the Spectrum of the Cosmic Background Radiation, *Physical Review Letters*, **51**, No. 12, 1099, 1983.
48. Structure of the Universe and Fluctuations in the Cosmic Microwave Background, in *Origins and Evolution of Galaxies*, p. 121, B. J. T. Jones and J. E. Jones, eds., D. Reidel, 1983.
49. (with J. Cannon* *et al.*) Automated Measurement of the Temperature of the Atmosphere at 3.2 cm., *Physical Review, D*, **29**, 2683, 1984.

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- †50. (with J. E. Knoke,* M. I. Ratner and I. I. Shapiro) Limits on Arcsecond-Scale Fluctuations in the Cosmic Microwave Background, *Astrophysical Journal*, **284**, 479, 1984.
51. (with G. Sironi *et al.*) Spectrum of the Cosmic Background Radiation, in *Eleventh Texas Symposium on Relativistic Astrophysics*, ed. D. S. Evans, Annals of the New York Academy of Sciences, vol. **422**, 383 (1984).
52. (with N. Mandolesi *et al.*) Spectrum of the Cosmic Background Radiation, in *Formation and Evolution of Galaxies and Large Structures in the Universe*, ed. J. Audouze and J. Tran Thanh Van, p. 109, Reidel Co., Dordrecht, Holland (1984).
53. (with G. Smoot *et al.*) Low-Frequency Measurements of the Cosmic Background Radiation Spectrum, *Astrophysical Journal (Letters)*, **291**, L23, 1985.
54. (with N. Mandolesi *et al.*) Large Scale Homogeneity of the Universe, *Nature*, **319**, 751, 1986.
55. (with S. Radford *et al.*) A Search for the Sunyaev-Zel'dovich Effect at $\lambda = 3$ mm, *Astrophysical Journal*, **300**, 159, 1986.
56. Very Small Scale Anisotropies of the Microwave Background, in *Inner Space/Outer Space*, Kolb and Turner, eds., Univ. Chicago Press, 1986.
57. The Cosmic Microwave Background Twenty Years after its Discovery, *The Cosmic Background Radiation and Fundamental Physics*, **1**, Italian Physical Society, 1986.
58. (with G. Sironi *et al.*) A Redetermination of the Spectrum of the Cosmic Background Radiation from 12 to 0.33 cm, *ibid*, **7**, 1986.
59. The Cosmic Microwave Background at its 20th Anniversary, in *Proceedings of the 12th Texas Symposium, Jerusalem* (Annals of the New York Academy of Sciences, 470), 36, 1986.
60. (with K. Hilldrup and M. Ratner) Radio Source Counts at 6 cm to 0.1 Millijansky, *Astrophysical Journal*, **308**, 46, 1986.
61. (with others) Gravitation, Cosmology and Cosmic-Ray Physics, part of the series, *Physics through the 1990's*, National Academy Press, 1986.
62. The Angular Distribution of the Cosmic Background Radiation, *Highlights of Astronomy* J.-P. Swings, ed., Reidel Publ. Co., Dordrech, Holland, 1986.
63. Boundaries and Voices—A View from the Trenches, *Journal of College Student Psychotherapy*, **1**, 29, 1986.
64. The Cosmic Microwave Background, in *Observational Cosmology, IAU Symposium 124*, A. Hewitt *et al.*, eds., Reidel Publ. Co., Dordrecht, Holland, 1987.

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65. The 3K Cosmic Background Radiation and Galaxy Formation—an Introduction for Physicists, in *Proceedings of the Seventh Workshop on Grand Unification*, J. Arafune, ed., World Scientific Publ. Co., Singapore, 1987.
66. (with R. A. Perley, N. Mandolesi and F. Delpino) VLA Limits on the Sunyaev-Zel'dovich Effect in Abell 2218, *Astrophysical Journal*, **317**, 112, 1987.
- †67. (with R. H. Donnelly* and R. A. Windhorst) Radio Source Counts and Spectral Index Studies down to 0.1 Millijansky, *Astrophysical Journal*, **321**, 94, 1987.
68. (with L. Bassani, M. J. Coe, N. Mandolesi and L. Spinoglio) On the Identification of IRAS Deep Field Sources: The Radio Counterparts, in *European Space Agency Symposium on Millimeter Wave Astronomy*, Segovia, Spain, 1987.
69. Observations of the Microwave Background, p. 173 in *Theory and Observational Limits in Cosmology*, ed. W. R. Stoeger, Specola Vaticana, Vatican, 1987.
70. H_0 from the Sunyaev-Zel'dovich Effect; A Way—Perhaps—to Measure Proper Motions; Observational Constraints on "Small Universes," *ibid*, p. 379, 383 and 487, 1987.
71. Search for Intergalactic Light in Clusters of Galaxies, *ibid*, p. 463, 1987.
72. (with M. J. Coe, L. Bassani and L. Spinoglio) 1652+395—A New IRAS-selected Seyfert Galaxy, IRAS Conference, London, 1987.
73. La Formazione delle Galassie, *Nuovo Secondaria*, 15 March 1988, p. 19.
74. (with H. M. Martin*) A Search for Small Scale Structure in the Background Radiation at 6 cm, *Astrophysical Journal*, **324**, 794, 1988.
- †75. The Angular Distribution of the Cosmic Background Radiation, *Reports on Progress in Physics*, **51**, 647, 1988.
76. (with J. Nowakowski and H. M. Martin) Linear Polarized Fluctuations in the Cosmic Microwave Background, *Nature*, **311**, 146, 1988.
77. Report on the NSF Disciplinary Workshops on Undergraduate Education (Physics; with others), 1989.
78. The Cosmic Background Radiation: What We Learn from the Observational Results, Especially the Null Results, in *Proceedings of the 20th Yamada Conference*, ed. S. Hayakawa and K. Sato, Universal Academic Press, Tokyo, 1989.
79. The Imprint of Large Scale Structure on the Cosmic Background Radiation in *Large-Scale Structure and Motions in the Universe*, ed. G. Giuricin *et al.*, Kluwer Academic Publ., 1988.
80. The Cosmic Microwave Background Radiation and the Dog in the Night, in *Third ESO/CERN Symposium, Astronomy, Cosmology and Fundamental Physics*, ed. M. Caffo *et al.*, Kluwer Academic Publ., Dordrecht, Netherlands 1988.

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81. (with O. Lahav) Contributions to the Microwave Background Dipole from Galaxies, and Constraints on the Anisotropy of the Far-infrared Background, *Monthly Notices Roy. Astr. Soc.*, **235**, 1 p., 1988.
82. (with L. Danese) Atmospheric Emission Models: Confrontation between Observational Data and Predictions in the 2.5 to 300 GHz Frequency Range, *Ap. J.*, **342**, 604, 1989.
83. (with R. Sheth*) High Sensitivity Continuum Observations at the 12-Meter Telescope, one in a series of 12-m Memos maintained by the National Radio Astronomy Observatory, 1989.
84. (with C. Hogan) New Limits on Microwave Background Anisotropy at Small Angular Scales, *Ap. J. (Letters)*, **341**, L29, 1989.
85. (with Bassani and others) A New Narrow-Line Seyfert 1 Galaxy: IRAS 1652+395, *Ap. J.*, **344**, 726, 1989.
86. (with A. L. Kiplinger and M. A. Bershadsky*) A Search for Intergalactic Light in Clusters of Galaxies, preprint, 1989.
87. (with S. P. Boughn) The Microwave Background Radiation in *Encyclopedia of Astronomy*, 1989.
88. Searches at Short Wavelengths for Small-Scale Anisotropies in the 3 K and Submillimeter Backgrounds, in *Particle Astrophysics: Forefront Experimental Issues*, ed. E. B. Norman, World Scientific Publ. Co., Singapore, 1989.
89. Concluding Remarks—Observations, in *The Cosmic Microwave Background 25 Years Later*, ed. N. Mandolesi and N. Vittorio, Kluwer Academic Publ., Dordrecht, Holland, 1990.
90. The Cosmic Microwave Background: The Present Status of the Observations and Implications for General Relativity, in *Proceedings of the 12th International Conference on General Relativity and Gravitation*, ed. N. Ashby, D. E. Bartlett and W. Wyss, Cambridge Univ. Press, Cambridge, 1990.
91. Extragalactic Backgrounds: Common Features and New Work on Intracluster Light, in *IAU Symposium 139, The Galactic and Extragalactic Background Radiation*, ed. S. Bowyer and C. Leinert, Kluwer Academic Publ., Dordrecht, Holland, 1990.
92. Cosmological Parameters Derived from the Cosmic Microwave Background Radiation, in *The Quest for the Fundamental Constants in Cosmology*, ed., J. Audouze and J. Tran Thanh Van, Editions Frontières, Gif-sur-Yvette, France, 1990.
93. The Spectrum of the Cosmic Blackbody Radiation from Bell Labs to COBE, *Scienze e Tecnica*, 1990.

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94. (with P. Hartnett*) Interaction of Clusters and Protoclusters with the Microwave Background, in *Superclusters and Clusters of Galaxies and Environmental Effects*, ed. G. Giuricin, F. Mardirossian, M. Mezgetti, Sesto Pusteria Workshop, 1990.
95. The Cosmic Microwave Background Radiation, *Highlights in Astronomy*, I.A.U. General Assembly 20, 1990.
96. (with E. B. Fomalont, J. D. Lowenthal and R. A. Windhorst) Fine-Scale Microwave Fluctuations at $\lambda = 3.6$ cm, in *After the First Three Minutes*, ed. S. Holt *et al.*, American Inst. of Physics, New York, 1990.
97. (with S. Cortiglioni, G. Giovannini, N. Mandolesi, G. Morigi, G. Ventura and S. Boughn) A Balloon-Borne Experiment for Observations of the Near-Infrared Cosmological Background, *Nuovo Cimento C13*, **529**, 1990.
98. Fluctuations in the Cosmic Microwave Background: The first Measurements (and Motivation), and Recent Results, in *Physical Cosmology*, eds. A. Blanchard, L. Celnikier, M. Lachièze-Rey and J. Tran Thanh Van, Editions Frontières, Gif-sur-Yvette, France, 1991.
99. Recent Observations of the Cosmic Microwave Background and Their Implications for Cosmology, in *Cosmology and Large-Scale Structure in the Universe*, ed. R. de Carvalho, Kluwer Acad. Publ. Co., Dordrecht, Netherlands, 1992.
100. Perspective: The Seeds of Cosmic Structure, *Science*, **257**, 178, 1992.
101. Sub-Arcminute Fluctuations, in *Highlights in Astronomy*, **9**, ed. J. Bergeron, Kluwer Acad. Publ. Co., Dordrecht, Netherlands, 1993.
- †102. (with E. B. Fomalont, J. D. Lowenthal and R. A. Windhorst) Limits to Cosmic Background Fluctuations at 8.44 GHz between Angular Scales 10" to 200", *Ap. J.*, **404**, 8, 1993.
103. (with R. A. Windhorst, E. B. Fomalont and J. D. Lowenthal) Micro-Jansky Source Counts and Spectral Indices at 8.44 GHz, *Ap. J.*, **405**, 498, 1993.
104. Microwave and Millimeter-Wave Properties of Starforming Galaxies in *First Light in the Universe*, eds. B. Rocca-Volmerange *et al.*, Editions Frontières, Gif-sur-Yvette, France, 1993.
105. (with R. A. Windhorst, E. B. Fomalont and J. D. Lowenthal) Limits to the 8.4 GHz Nano-Jansky Source Counts and Arcmin Scale CBR Fluctuations, in the Milano International Symposium on "Observational Cosmology," ed. G. Chincarini, A. Iovino, T. Maccacaro, and D. Maccagni, ASP Conf. Ser. Vol. **51** (Provo, UT: BookCrafters, Inc.), 1993.
106. The Small Scale Anisotropy of the Cosmic Microwave Background Radiation: Primary and Secondary Fluctuations, in: *Second Course, Current Topics in Astrofundamental Physics*, eds. N. Sanchez and A. Zichichi, World Scientific, Singapore, 1993.

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