

# PATRICK THADDEUS

## Curriculum Vitae

Harvard University  
Division of Engineering and Applied Sciences  
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Cambridge, Massachusetts 02138  
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### CURRENT POSITIONS

Robert Wheeler Willson Professor of Applied Astronomy, and  
Professor of Applied Physics, Harvard University  
Senior Space Scientist, Smithsonian Astrophysical Observatory  
Staff member, Harvard-Smithsonian Center for Astrophysics

### EDUCATION

Ph.D., Physics, Columbia University, 1960  
Thesis: Beam Maser Spectroscopy (Adviser: C. H. Townes)  
M.A., Theoretical Physics, University of Oxford (U.K.), 1955  
B.Sc., Physics, University of Delaware, 1953

### HONORS AND AWARDS

Honorary Doctor of Science, University of Chicago, 2003  
Sir Harold Thompson Memorial Award 2002  
Herschel Medal, Royal Astronomical Society, 2001  
Fairchild Distinguished Scholar, California Institute of Technology, 1994  
Russell Marker Lecturer, Pennsylvania State University, 1989  
Election to the American Academy of Arts and Sciences, 1989  
Election to the National Academy of Sciences, 1987  
Medal for Exceptional Scientific Achievement, NASA, 1985  
John C. Lindsay Memorial Award, National Aeronautics and Space Administration,  
Goddard Space Flight Center, 1976  
Medal for Exceptional Scientific Achievement, NASA, 1970  
Postdoctoral Fellowship, National Academy of Sciences, National Research Council,  
1961-64  
Fulbright Fellowship, 1953-1955

### PROFESSIONAL MEMBERSHIPS

Fellow, American Physical Society  
American Astronomical Society  
International Astronomical Union  
Sigma Xi

## ADVISORY COMMITTEES

NASA Astrobiology Oversight Committee, 1999--2002

Center for Astrophysical Research in Antarctica (CARA), 1999--

Chair: Task Group on Space Astronomy and Astrophysics, National Research Council, 1996--97

President's Visiting Committee, Caltech, 1995

Visiting Committee, National Radio Astronomy Observatory, 1991-94; Chair 1994

Steering Committee, SAO Submillimeter Array, 1993-

Director's Advisory Committee, NRAO Green Bank Telescope Project 1989-90

Astronomy Survey Committee 1989-90 , Radio Astronomy Panel, Infrared Panel, and Theory and Laboratory Astrophysics Panel

Scientific Organizing Committee, IAU Symposium No. 147, on Fragmentation of Molecular Clouds and Star Formation, Grenoble, 1990

National Radio Astronomy Observatory Ad Hoc Long-Range Planning Committee, 1988

NASA Management Operations Working Group for Infrared Astronomy, 1987- 1990

International Organizing Committee, Cologne- Zermatt International Symposium on the Physics and Chemistry of Interstellar Clouds, Zermatt, 1988

Scientific Committee, Meeting on "Polycyclic Molecules and Astrophysics," Les Houches, 1986

Visiting Committee, Department of Astronomy and Astrophysics, University of Chicago, 1983

AURA Visiting Committee (Kitt Peak, Cerro Tololo, and Sacramento Peak Observatories), 1983-86

NASA Management Operations Working Group for Airborne Astronomy, 1982-1986

Visiting Committee, Haystack Observatory, Mass. Inst. of Technology, 1982-85; Chair, 1985

Scientific Organizing Committee, Symposium on the Orion Nebula to Honor Henry Draper, New York, 1981

Visiting Committee, Hat Creek Observatory, University of California, 1981

Universities Research Association (URA), Astronomy Advisory Committee, 1979-81

NASA Space Science Advisory Committee, 1979

Astronomy Survey Committee, 1978-80; Chair, Radio Astronomy Panel; report published as *Astronomy and Astrophysics for the 1980s* (National Academy Press, 1982; 2)

Submillimeter Space Telescope Working Group, 1977

Editorial Board, *The Astrophysical Journal*, 1976-80

Scientific Organizing Committee, IAU Symposium No. 75, on "Star Formation," Geneva, 1976

Visiting Committee, National Radio Astronomy Observatory, 1973-76

## PREVIOUS POSITIONS

- 1964–86 Goddard Institute for Space Studies, National Aeronautics and Space Administration, New York, N.Y.  
Research Physicist, 1964–86  
Resident Research Associate, 1961–64
- 1960–86 Columbia University, New York, N.Y.  
Adjunct Professor of Physics, 1971–86  
Adjunct Associate Professor, 1968–71  
Adjunct Assistant Professor, 1965–68  
Research Associate, Columbia Radiation Laboratory, 1960–61
- 1983–84 University of Cambridge (U.K.), Institute of Astronomy, Senior Visiting Fellow
- 1968 University of California at Berkeley, Visiting Professor of Astronomy
- 1966–67 State University of New York at Stony Brook, Adjunct Associate Professor

## DISSERTATIONS SUPERVISED

1. William Ho, Physics Department, Columbia University (1966)  
"Laboratory Measurement of Microwave Absorption in Models of the Atmosphere of Venus"
2. Irwin A. Kaufman, Physics Department, Columbia University (1967)  
"Microwave Pressure Broadening on O<sub>2</sub> and H<sub>2</sub>O Above One Atmosphere"
3. John F. Clauser, Physics Department, Columbia University (1969)  
"Measurement of the Cosmic Microwave Background by Optical Observations of Interstellar Molecules"
4. John Diamante, Department of Aeronautics and Astronautics, New York University (1969)  
"The Structure and Circulation of the Lower Atmosphere of Venus"
5. Richard E. White, Astronomy Department, Columbia University (1971)  
"Microwave Radiative Transfer in Interstellar Formaldehyde"
6. John F. Moore, Physics Department, Columbia University (1971)  
"Infrared Absorption of Carbon Dioxide at High Densities with Application to the Atmosphere of Venus"
7. Marc L. Kutner, Physics Department, Columbia University (1972)  
"Interstellar Molecules in Ultra-Dense Regions"
8. Kenneth D. Tucker, Physics Department, Columbia University (1972)  
"Hyperfine Structure in the Spectrum of Formaldehyde and Its Isotopic Species"
9. Victor J. Bortolot, Jr., Physics Department, New York University (1972)  
"The Interstellar Line Spectra of Zeta Ophiuchi and Zeta Persei"
10. Richard Nerf, Physics Department, Columbia University (1973)  
"Microwave Pressure Broadening of Formaldehyde"
11. Robert L. Dickman, Physics Department, Columbia University (1975)  
"The Ratio of Carbon Monoxide to Molecular Hydrogen in Interstellar Dark Clouds"
12. Linda Gaines, Physics Department, Columbia University (1977)  
"Hyperfine Structure in Pyrrole and Pyradine"
13. Gordon Chin, Physics Department, Columbia University (1977)  
"Carbon Monoxide Survey of the Orion Region"
14. Hong-Ih Cong, Physics Department, Columbia University (1977)  
"Carbon Monoxide Survey of the Cygnus X Region"
15. Richard S. Cohen, Physics Department, Columbia University (1977)  
"The Galactic Distribution of Carbon Monoxide: An Out-of-Plane Survey"
16. Leo Blitz, Astronomy Department, Columbia University (1978)  
"Giant Molecular Clouds Associated with the Rosette Nebula, NGC 2264, and CMa OB-1"
17. Gregory Baran, Astronomy Department, Columbia University (1982)  
"A CO Survey of the Dark Clouds in Taurus and Perseus"

18. Thomas M. Dame, Astronomy Department, Columbia University (1982)  
"Molecular Clouds and Galactic Spiral Structure"
19. Yi-Long Huang, Physics Department, Columbia University (1985)  
"Molecular Clouds and Supernova Remnants"
20. Ronald J. Maddalena, Astronomy Department, Columbia University (1985)  
"The Molecular Clouds in Orion and Monoceros"
21. David Leisawitz, Astronomy Department, University of Texas at Austin (1985)  
"Molecular Clouds and Galactic Clusters" (Supervision in N.Y.;  
main supervisor was F. N. Bash, University of Texas)
22. David Grabelsky, Astronomy Department, Columbia University (1985)  
"Molecular Clouds in the Carina Region"
23. Leonardo Bronfman, Physics Department, Columbia University (1986)  
"A CO Survey of Molecular Clouds in the Southern Milky Way"
24. Mauricio Bitran, Astronomy Department, University of Florida at Gainesville (1987)  
"CO in the Galactic Center" (Co-advisor with S. Gottesman)
25. Hendrik W. De Vries, Astronomy Department, Columbia University (1987)  
"High-Latitude Molecular Clouds and Infrared Cirrus"
26. Seth Digel, Physics Department, Harvard University (1991)  
"Molecular Clouds in the Distant Outer Galaxy"
27. Reza Mollaaghababa, Physics Department, Harvard University (1992)  
"Millimeter-wave Spectroscopy of Three Highly Reactive Astrophysical Molecules: SiC, SiO,  
and C<sub>3</sub>H<sub>2</sub>"
28. Richard Oliver, Physics Department, University of Bristol, UK (1996)  
"Molecular Clouds in the Outer Galaxy--A New CO Survey of the Monoceros OB1 Region"  
(Bristol supervisor: Dr. Michael Masheder)
29. Will Lang, Physics Department, University of Bristol, UK (1998)  
"Molecular Clouds in the Lambda Orionis Ring" (Bristol supervisor:  
Dr. Michael Masheder)
30. Bruno Alexander Wilson, Physics Department, University of Bristol, UK [2001]  
Tentative title: "The Molecular Clouds in Orion" (Bristol supervisor:  
Dr. Michael Masheder)

## RECENT INVITED PAPERS

- "Carbon Chains in the Diffuse Interstellar Gas," American Physical Society, Chicago, Illinois (June 1, 1999).
- "Carbon Chains and Exotic Rings in the Laboratory and in Space," Third Cologne-Zermatt Symposium: "The Physics and Chemistry of the Interstellar Medium", Zermatt, Switzerland (September 22-25, 1993).
- "New Carbon Chains in the Laboratory and in Interstellar Space," Faraday Discussions No. 109: "Chemistry and Physics of Molecules and Grains in Space," Nottingham, England (April 15, 1998).
- "Twenty Seven New CarbonChain Molecules," American Chemical Society, New York Section, New York, New York (January 24, 1998).
- "Nineteen New Carbon Chain Molecules," Twenty-fourth International Symposium on Free Radicals, Taellberg, Sweden (August 18, 1997).
- "Large Organic Molecules in the Interstellar Gas," Leermakers Symposium, Wesleyan University, Middletown, Connecticut (May 5, 1997).
- "CO Surveys of the Milky Way and its Nearest Neighbors," IAU Symposium 170: 'CO: Twenty-five Years of Millimeter-wave Spectroscopy,' Tucson, Arizona (May 29, 1995).
- "The Distribution of Gas in Orion," Workshop on the Evolution of Star Forming Regions, Cambridge, Massachusetts (October 24, 1994).
- "Long Carbon Chains in the Interstellar Gas," 'Dust, Molecules, and Backgrounds', Capri, Italy (September 12, 1994).
- "The Distribution of Molecular Gas in the Galaxy," 'The Physics of the Interstellar Medium and the Intergalactic Medium: a Meeting in Honor of Prof. George B. Field', Elba, Italy (June 20, 1994).
- "New Interstellar Molecules," 49th Ohio State International Symposium on Molecular Spectroscopy, Columbus, Ohio (June 3, 1994).
- "Carbon Chains and the Diffuse Interstellar Bands," International Conference on the Diffuse Interstellar Bands, Boulder, Colorado (May 19, 1994).
- "From Chains to Rings to Fullerenes to Grains," Royal Astronomical Society, Discussion Meeting on the Diffuse Interstellar Absorption Lines, London, UK (November 12, 1993).
- "Molecular Clouds in the Galaxy," Second Cologne-Zermatt Symposium: "The Physics and Chemistry of Interstellar Molecular Clouds", Zermatt, Switzerland (September 21, 1993).
- "Large Organic Molecules in the Interstellar Gas," Brioni International Conferences on Interdisciplinary Topics in Chemistry and Physics IV, Brioni, Yugoslavia (September 16, 1993).
- "On the Large Organic Molecules in the Interstellar Gas," 50th International Meeting of Physical Chemistry: 'Molecules and Grains in Space', Mont Sainte-Odile, France (September 9, 1993).
- "Molecular Clouds in the Galaxy," Meeting of the Max Planck Institute to Celebrate 25 Years of Molecular Astronomy, Ringberg Castle, Germany (April 15, 1993).
- "Spectroscopy of Vibrationally Excited Reactive Molecules of Interest to Radio Astronomy," Royal Society of Chemistry, High Resolution Spectroscopy Group, Oxford, England (December 21, 1992).
- "Free Carbenes in the Interstellar Gas," Royal Society of Chemistry, Faraday Symposium No. 28: 'Chemistry in the Interstellar Medium,' Birmingham, England (December 17, 1992).
- "Reactive Organic Molecules in the Interstellar Gas," 201st American Chemical Society National Meeting, Atlanta, Georgia (April 16, 1991).
- "Peering into the Heart of Darkness: Exotic Molecules in Space," Symposium Celebrating the 150th Anniversary of the Harvard College Observatory and the 100th Anniversary of the Smithsonian Astrophysical Observatory, Cambridge, Massachusetts (November 3, 1990).

## PUBLICATIONS

1. "Beam Maser Spectroscopy on Formaldehyde," P. Thaddeus, J. Loubser, J. Krisher, and H. Lecar, 1959, *Journal of Chemical Physics*, **31**, 1677.
2. "Beam Maser Spectroscopy on HDO," P. Thaddeus and J. Loubser, 1959, *Nuovo Cimento*, **13**, 1060.
3. "Use of Some New Molecules in a Beam Type Maser for Spectroscopy and Frequency Standards," P. Thaddeus, J. Loubser, A. Javan, L. Krisher, and H. Lecar, in *Quantum Electronics*, ed. C. H. Townes (New York: Columbia University Press, 1960).
4. "A Beam Maser Spectrometer," P. Thaddeus and L. C. Krisher, 1961, *Review of Scientific Instruments*, **32**, 1083.
5. "Optical Detection of Level Crossing in the (5s5p)  $^3P_1$  State of Cd<sup>111</sup> and Cd<sup>113</sup>," P. Thaddeus and R. Novick, 1962, *Physical Review*, **126**, 1774; reprinted in *Optical Pumping*, ed. R. A. Bernheim (Benjamin Press, 1965).
6. "Level Crossings in the (5s5p)  $^3P_1$  State of Radioactive Cd<sup>107</sup> and Cd<sup>109</sup>," P. Thaddeus and M. N. McDermott, 1963, *Physical Review*, **132**, 1186.
7. "Hyperfine Structure in the Microwave Spectrum of HDO, HDS, CH<sub>2</sub>O and CHDO," P. Thaddeus, L. C. Krisher, and J. Loubser, 1964, *Journal of Chemical Physics*, **40**, 257.
8. "Recent Earth-Based and Space-Probe Studies of the Atmospheres of Mars and Venus," P. Thaddeus, 1964, *Journal of the British Interplanetary Society*, **19**, 419.
9. "Hyperfine Structure in the Microwave Spectrum of NH<sub>2</sub>D," P. Thaddeus, L. C. Krisher, and P. Cahill, 1964, *Journal of Chemical Physics*, **41**, 1542.
10. "gJ of the (5s5p)  $^3P_1$  Level of Cd and the (6s6p)  $^3P_1$  Level of Hg by High-Field Double Resonance," R. Kohler and P. Thaddeus, 1964, *Physical Review*, **134**, A1204.
11. "The Atmosphere of Venus," P. Thaddeus, 1965, *Advances in the Astronautical Sciences*, **19**, 201.
12. "Cosmic Microwave Radiation at 2.63 mm from Observations of Interstellar CN," P. Thaddeus and J. F. Clauser, 1966, *Physical Review Letters*, **16**, 819.
13. "Microwave Absorption in Compressed CO<sub>2</sub>," W. Ho, I. A. Kaufman, and P. Thaddeus, 1966, *Journal of Chemical Physics*, **45**, 877.
14. "Laboratory Measurement of Microwave Absorption in Models of the Atmosphere of Venus," W. Ho, I. A. Kaufman, and P. Thaddeus, 1966, *Journal of Geophysical Research*, **71**, 5091.
15. "Reversal of Postsynaptic Potentials in Non-Isopotential Systems," M. V. L. Bennett, A. R. Freeman, and P. Thaddeus, 1966, *Biophysical Journal*, **6**, 123.
16. "The Cosmic Microwaves," P. Thaddeus, The University of Delaware News, Alumni Magazine, Spring 1966. (Popular)
17. "Preliminary Results from Aircraft Flight Tests of an Electrically Scanning Microwave Radiometer," C. Catoe, W. Nordberg, P. Thaddeus, and G. Ling, Goddard Space Flight Center Report X-622-67-352, August 1967.
18. "The Dry Massive Model of the Atmosphere of Venus and Microwave Phase Effect," P. Thaddeus, in *The Atmospheres of Venus and Mars*, eds. J. C. Brandt and M. B. McElroy (New York: Gordon & Breach, 1968), 99–102.
19. "Measurements of the Cosmic Background with Interstellar Molecules," P. Thaddeus, in *Infrared Astronomy*, eds. P. J. Brancazio and A. G. W. Cameron (New York: Gordon & Breach, 1968), 101–108.

20. "The Dry Massive Model of the Atmosphere of Venus," P. Thaddeus, in *Infrared Astronomy*, eds. P. J. Brancazio and A. G. W. Cameron (New York: Gordon & Breach, 1968), 165–171.
21. "Dependence of the Radio and Radar Spectra of Venus on Surface Conditions," P. Thaddeus, 1968, *Journal of the Atmospheric Sciences*, **25**, 665.
22. "Pressure-Induced Microwave Absorption in N<sub>2</sub>," W. Ho, I. A. Kaufman, and P. Thaddeus, 1968, *Journal of Chemical Physics*, **49**, 3627.
23. "Probable Detection of Interstellar C<sup>13</sup>H<sup>+</sup>," V. J. Bortolot, Jr., and P. Thaddeus, 1969, *Astrophysical Journal Letters*, **155**, 17.
24. "Upper Limits to the Intensity of Background Radiation at  $\lambda = 1.32, 0.559, \text{ and } 0.539 \text{ mm}$ ," V. J. Bortolot, Jr., J. F. Clauser, and P. Thaddeus, 1969, *Physical Review Letters*, **22**, 307.
25. "Microwave Observation of Sea State from Aircraft," W. Nordberg, J. Conaway, and P. Thaddeus, 1969, *Quarterly Journal of the Royal Meteorological Society*, **95**, 408.
26. "Search of Rapid Fluctuations in Light from the Crab Nebula Pulsar," D. Hegyi, R. Novick, and P. Thaddeus, 1969, *Astrophysical Journal Letters*, **158**, L77.
27. "Precise Laboratory Measurement of the 4830 MHz Formaldehyde Rotational Transition," K. D. Tucker, G. R. Tomasevich, and P. Thaddeus, 1970, *Astrophysical Journal Letters*, **161**, L153.
28. "A Search for Variations in the Intensity of the Optical Pulses from NP0532," D. Hegyi, R. Novick, and P. Thaddeus, in *The Crab Nebula*, eds. R. D. Davies and F. G. Smith (Dordrecht: Reidel, 1971).
29. "Observation of 140 GHz Formaldehyde Line Emission from the Trapezium Region of the Orion Nebula," M. Kutner, P. Thaddeus, K. B. Jefferts, A. A. Penzias, and R. W. Wilson, 1971, *Astrophysical Journal Letters*, **164**, L49.
30. "An Initial Search for the Formyl Radical, HCO, and for HC<sup>13</sup>O<sup>+</sup>," K. B. Jefferts, M. Kutner, A. A. Penzias, P. Thaddeus, and R. W. Wilson, 1971, *Astrophysical Letters*, **8**, 43.
31. "Discovery of Interstellar Silicon Monoxide," R. W. Wilson, A. A. Penzias, K. B. Jefferts, M. Kutner, and P. Thaddeus, 1971, *Astrophysical Journal Letters*, **167**, L97.
32. "Discovery of Para-formaldehyde and the 2 mm Formaldehyde Distribution in the Orion Infrared Nebula," P. Thaddeus, R. W. Wilson, M. Kutner, A. A. Penzias, and K. B. Jefferts, 1971, *Astrophysical Journal Letters*, **168**, L59.
33. "6-cm Formaldehyde Absorption and Emission in the Orion Nebula," M. Kutner and P. Thaddeus, 1971, *Astrophysical Journal Letters*, **168**, L67.
34. "Laboratory Measurement of the 6-cm Formaldehyde Transitions," K. D. Tucker, G. R. Tomasevich, and P. Thaddeus, 1971, *Astrophysical Journal*, **169**, 429.
35. "Lower Limit to the Interstellar C<sup>12</sup>/C<sup>13</sup> Ratio in the Direction of 20 Tauri," P. Vanden Bout and P. Thaddeus, 1971, *Astrophysical Journal*, **170**, 297.
36. "Interstellar Formaldehyde. I. The Collisional Pumping Mechanism for Anomalous 6-cm Absorption," P. Thaddeus, 1972, *Astrophysical Journal*, **173**, 317.
37. "Interstellar Molecules," P. Thaddeus, 1972, *Science Year*.
38. "Survey of Molecular Lines Near the Galactic Center. I.," N. Z. Scoville, P. M. Solomon, and P. Thaddeus, 1972, *Astrophysical Journal*, **172**, 335.
39. "Search for Interstellar Furan and Imidazole," R. L. deZafra, P. Thaddeus, M. Kutner, N. Scoville, P. M. Solomon, H. Weaver, and D. R. W. Williams, 1972, *Astrophysical Letters*, **10**, 1.

40. "Laboratory Measurement of the 2-cm,  $2_{11} - 2_{12}$ , Transition of Normal Formaldehyde and Its Carbon-13 and Oxygen-18 Isotopic Species," K. D. Tucker, G. R. Tomasevich, and P. Thaddeus, 1972, *Astrophysical Journal*, **174**, 463.
41. "The Short Wavelength Spectrum of the Microwave Background," P. Thaddeus, 1972, *Annual Review of Astronomy and Astrophysics*, **10**, 305.
42. "Interstellar Hydrogen Sulfide," P. Thaddeus, M. Kutner, R. W. Wilson, A. A. Penzias, and K. B. Jefferts, 1972, *Astrophysical Journal Letters*, **176**, L73.
43. "Interstellar Nitrogen-15, and U169.3 — Possibly a New Methanol Line," R. W. Wilson, A. A. Penzias, K. B. Jefferts, P. Thaddeus, and M. L. Kutner, 1972, *Astrophysical Journal Letters*, **176**, L77.
44. "Hyperfine Structure of Furan," G. R. Tomasevich, K. D. Tucker, and P. Thaddeus, 1973, *Journal of Chemical Physics*, **59**, 131.
45. "New Interstellar Methanol Lines," M. L. Kutner, P. Thaddeus, A. A. Penzias, R. W. Wilson, and K. B. Jefferts, 1973, *Astrophysical Journal Letters*, **183**, L27.
46. "Oscillator Strengths for the  $X^1 \Sigma^+ - A^1 \Pi$  System of  $\text{CH}^+$ ," M. Yoshimine, S. Green, and P. Thaddeus, 1973, *Astrophysical Journal*, **183**, 899.
47. "A Large Carbon Monoxide Cloud in Orion," K. D. Tucker, M. L. Kutner, and P. Thaddeus, 1973, *Astrophysical Journal Letters*, **186**, L13.
48. "Vibrationally Excited Silicon Monoxide in the Orion Nebula," J. H. Davis, G. T. Blair, H. Van Till, and P. Thaddeus, 1974, *Astrophysical Journal Letters*, **190**, L117.
49. "Weak Interstellar Lines in the Visible Spectrum of  $\zeta$  Ophiuchi," S. Shulman, V. J. Bortolot, and P. Thaddeus, 1974, *Astrophysical Journal*, **193**, 97.
50. "Rotational Excitation of Hydrogen Cyanide by Collisions," S. Green and P. Thaddeus, 1974, *Astrophysical Journal*, **191**, 653.
51. "Detection of the  $J=1-0$  Rotational Transition of Vibrationally Excited Silicon Monoxide," P. Thaddeus, J. Mather, J. H. Davis, and G. N. Blair, 1974, *Astrophysical Journal Letters*, **192**, L33.
52. "The Ethynyl Radical  $\text{C}_2\text{H}$ —A New Interstellar Molecule," K. D. Tucker, M. L. Kutner, and P. Thaddeus, 1974, *Astrophysical Journal Letters*, **193**, L115.
53. "Tentative Identification of U93.174 as the Molecular Ion  $\text{N}_2\text{H}^+$ ," S. Green, J. A. Montgomery, Jr., and P. Thaddeus, 1974, *Astrophysical Journal Letters*, **193**, L89.
54. "Confirmation of Interstellar  $\text{N}_2\text{H}^+$ ," P. Thaddeus and B. E. Turner, 1975, *Astrophysical Journal Letters*, **201**, L25.
55. "Interstellar Chemistry," P. Thaddeus, 1975, *Proceedings of the Robert A. Welch Foundation Conferences on Chemical Research*, **19**, 241.
56. "Rotational Excitation of CO by Collisions with He, H, and  $\text{H}_2$  Under Conditions in Interstellar Clouds," S. Green and P. Thaddeus, 1976, *Astrophysical Journal*, **205**, 766.
57. "Theoretical Investigation of Protonated Carbon Dioxide," S. Green, H. Schor, P. Siegbahn, and P. Thaddeus, 1976, *Chemical Physics*, **17**, 479.
58. "Tentative Detection of the  $\text{C}_3\text{N}$  Radical," M. Guélin, and P. Thaddeus, 1977, *Astrophysical Journal Letters*, **212**, L81.
59. "On the Relationship of Interstellar  $\text{N}_2\text{H}^+$ ,  $\text{HCO}^+$ , HCN, and CN," B. E. Turner and P. Thaddeus, 1977, *Astrophysical Journal*, **211**, 755.

60. "Indirect Observation of Unobservable Interstellar Molecules," E. Herbst, S. Green, P. Thaddeus, and W. Klemperer, 1977, *Astrophysical Journal*, **215**, 503.
61. "An Out-Of-Plane Galactic Carbon Monoxide Survey," R. S. Cohen and P. Thaddeus, 1977, *Astrophysical Journal Letters*, **217**, L155.
62. "The Molecular Complexes in Orion," M. L. Kutner, K. D. Tucker, G. Chin, and P. Thaddeus, 1977, *Astrophysical Journal*, **215**, 521.
63. "Detection of Interstellar Ethyl Cyanide," D. R. Johnson, F. J. Lovas, C. A. Gottlieb, E. W. Gottlieb, M. M. Litvak, M. Guélin, and P. Thaddeus, 1977, *Astrophysical Journal*, **218**, 370.
64. "Molecular Clouds," P. Thaddeus in *Star Formation*, eds. T. de Jong and A. Maeder (Dordrecht: Reidel, 1977).
65. "Detection of the C<sub>4</sub>H Radical Toward IRC+10216," M. Guélin, S. Green, and P. Thaddeus, 1978, *Astrophysical Journal Letters*, **224**, L27.
66. "Molecular Clouds in the Vicinity of W3, W4, and W5," C. Lada, B. Elmegreen, H.-I. Cong, and P. Thaddeus, 1978, *Astrophysical Journal Letters*, **226**, L39.
67. "Detection of HC<sup>18</sup>O<sup>+</sup> in Sgr B2 (OH)," M. Guélin and P. Thaddeus, 1979, *Astrophysical Journal Letters*, **227**, L139.
68. "Observations of Interstellar H<sub>2</sub>O Emission at 183 GHz," J. W. Waters, J. J. Gustincic, T. B. H. Kuiper, H. K. Roscoe, P. N. Swanson, A. R. Kerr, and P. Thaddeus, 1980, *Astrophysical Journal*, **235**, 57.
69. "An Out-Of-Plane Survey of the First Galactic Quadrant," R. S. Cohen, G. R. Tomasevich, and P. Thaddeus, in *The Large Scale Characteristics of the Galaxy*, ed. W.B. Burton (Dordrecht: Reidel, 1979).
70. "Interstellar Methyl Mercaptan," R. A. Linke, M. A. Frerking, and P. Thaddeus, 1979, *Astrophysical Journal Letters*, **234**, L139.
71. "Interstellar Isothiocyanic Acid," M. A. Frerking, R. A. Linke, and P. Thaddeus, 1979, *Astrophysical Journal Letters*, **234**, L143.
72. "On C<sub>4</sub>H vs. Vibrationally Excited CO in IRC+10216," S. E. Cummins, M. Morris, and P. Thaddeus, 1980, *Astrophysical Journal*, **235**, 886.
73. "Giant Molecular Complexes and OB Associations: I. The Rosette Molecular Complex," L. Blitz and P. Thaddeus, 1980, *Astrophysical Journal*, **241**, 676.
74. "Molecular Clouds and Galactic Spiral Structure," R. S. Cohen, H.-I. Cong, T. M. Dame, and P. Thaddeus, 1980, *Astrophysical Journal Letters*, **239**, L53.
75. "Columbia CO Survey: Molecular Clouds and Spiral Structure," R. S. Cohen, T. M. Dame, and P. Thaddeus, 1980, I.A.U. Symposium No. 87, 205.
76. "Molecular Clouds in Orion and Monoceros," M. Morris, J. Montani, and P. Thaddeus, 1980, I.A.U. Symposium No. 87, 197.
77. "A Search for Interstellar Pyrrole: Evidence that Rings are Less Abundant than Chains," P. C. Myers, P. Thaddeus, and R. Linke, 1980, *Astrophysical Journal*, **241**, 155.
78. "The Abundance and Excitation of the Carbon Chains in Interstellar Molecular Clouds," V. Bujarrabal, M. Guélin, M. Morris, and P. Thaddeus, 1981, *Astronomy and Astrophysics*, **99**, 239.
79. "Three New 'Nonterrestrial' Molecules," P. Thaddeus, M. Guélin, and R. A. Linke, 1981, *Astrophysical Journal Letters*, **246**, L41.

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