

**Publications**  
**of**  
**Charles H. Townes**

0. "Design and Construction of a Source of High-Velocity Ions", Master's Thesis, Duke University, 1936.
1. "Greaseless Vacuum Valves," *Rev. Sci. Instr.* **9**, 428 (1938).
2. "Apparent Anomalous Isotope Effect in Some Bands Associated with the Swan Bands," *Nature* **144**, 631 (1939).
3. "The Spin of Carbon Thirteen," with W.R. Smythe, *Phys. Rev.* **56**, 1210 (1939).  
"Concentration of the Heavy Isotope of Carbon and Measurement of its Nuclear Spin", Ph.D. Thesis at California Institute of Technology, 1939
4. "Theory of Cathode Sputtering in Low Voltage Gaseous Discharges," *Phys. Rev.* **65**, 319 (1944).
5. "Water Spectrum Near One-Centimeter Wave-Length," with F.R. Merritt, *Phys. Rev.* **70**, 558 (1946).
6. "The Ammonia Spectrum and Line Shapes Near 1.25 cm Wave-Length," *Phys. Rev.* **70**, 665 (1946).
7. "Interpretation of Radio Radiation from the Milky Way," *ApJ* **105**, 235 (1946).
8. "Rotational spectra of Some Linear Molecules near 1 cm Wave-Length," with A.N. Holden and F.R. Merritt, *Phys. Rev.* **71**, 64 (1947).
9. "The Quadrupole Moments and Spins of Br, Cl, and N Nuclei," with A.N. Holden, J. Bardeen, and F.R. Merritt, *Phys. Rev.* **71**, 644 (1947).
10. "Electrostatic Field Strengths in Molecules and Nuclear Quadrupole Moments," *Phys. Rev.* **71**, 909 (1947).
11. "Microwave Spectra of Linear Molecules," with A.N. Holden and F.R. Merritt, *Phys. Rev.* **72**, 513 (1947).
12. "Stark Effect in High Frequency Fields," with F.R. Merritt, *Phys. Rev.* **72**, 1266 (1947).
13. "Calculation of Nuclear Quadrupole Effects in Molecules," with J. Bardeen, *Phys. Rev.* **73**, 97 (1948).
14. "Second-Order Corrections to Quadrupole Effects in Molecules," with J. Bardeen, *Phys. Rev.* **73**, 627 (1948).
15. "The Pure Rotational Spectrum of  $\text{ICl}_1$ ," with F.R. Merritt and B.D. Wright, *Phys. Rev.* **73**, 1334 (1948).
16. "Limiting Sensitivity of a Microwave Spectrometer," with S. Geschwind, *J. Appl. Phys.* **19**, 795 (1948).
17. "Spin and Quadrupole Moment of  $\text{S}^{33}$ ," with S. Geschwind, *Phys. Rev.* **74**, 626 (1948).
18. "Preliminary Analysis of the Microwave Spectrum of Ethylene Oxide," with R.G. Shulman and B.P. Daily, *Phys. Rev.* **74**, 846 (1948).
19. "Microwave Spectra of Some Linear XYZ Molecules," with A.N. Holden and F.R. Merritt, *Phys. Rev.* **74**, 1113 (1948).
20. " $\text{O}^{17}$  and  $\text{S}^{36}$  in the Rotational Spectrum of OCS," with W. Low, *Phys. Rev.* **75**, 529 (1949).
21. "Microwave Rotational Spectra and Structures of  $\text{GeH}_3\text{Cl}$ ,  $\text{SiH}_3\text{Cl}$ , and  $\text{CH}_3\text{Cl}$ ," with B.P. Daily and J.M. May, *Phys. Rev.* **76**, 136 (1949).
22. "Nuclear Spin and Quadrupole Moment of  $\text{Cl}^{36}$ ," with L.G. Aamodt, *Phys. Rev.* **76**, 691 (1949).
23. "Radioactivity of Chlorine<sup>36</sup>," with C.S. Wu and L. Feldman, *Phys. Rev.* **76**, 692 (1949).
24. "On the Spin and Beta-Spectrum of  $\text{Cl}^{36}$ ," with C. Longmire and C.S. Wu, *Phys. Rev.* **76**, 695 (1949).

25. "Evidence on Nuclear Moments of Stable Ge and Si Isotopes from Microwave Spectra," with J.M. Mays and B.P. Dailey, *Phys. Rev.* **76**, 700 (1949).
26. "Determination of Electronic Structure of Molecules from Nuclear Quadrupole Effects," with B.P. Dailey, *J. Chem. Phys.* **17**, 782 (1949).
27. "Nuclear Quadrupole Moments and Nuclear Shell Structure," with H.M. Foley and W. Low, *Phys. Rev.* **76**, 1415 (1949).
28. Molecular Dipole Moments and Stark Effects  
I. "Stark Effects on Symmetric Top Molecules with Nuclear Quadrupole Coupling," with W. Low, *Phys. Rev.* **76**, 1295 (1949)
29. "Hyperfine Structure and Exchange Narrowing of Paramagnetic Resonance," with J. Turkevich, *Phys. Rev.* **77**, 148 (1950)
30. "New Types of Microwave Transitions Involving I-type Doubling in OCS and HCN," with R.G. Shulman, *Phys. Rev.* **77**, 421 (1950)
31. Molecular Dipole Moments and Stark Effects II. "Stark Effects in OCS," with R.G. Shulman, *Phys. Rev.* **77**, 500 (1950).
32. "The Effect of Electronic Paramagnetism on Nuclear Magnetic Resonance Frequencies in Metal," with C. Herring and W.D. Knight, *Phys. Rev.* **77**, 852 (1950).
33. Molecular Dipole Moments and Stark Effects III. "Dipole Moment Determinations," with R.G. Shulman and B.P. Dailey, *Phys. Rev.* **78**, 145 (1950).
34. "Microwave Measurements on the Stable Selenium Isotopes in OCS<sub>e</sub>," with S. Geschwind, H. Minden, *Phys. Rev.* **78**, 174 (1950).
35. "Molecular Microwave Spectra Tables," with P. Kisliuk, *J. Res. N.B.S.* **44**, 611 (1950).
36. "The Microwave Spectra and Molecular Structure of Phosphorus and Arsenic Trichloride," with P. Kisliuk, *J. Chem. Phys.* **18**, 1109 (1950).
37. "Evidence from Nuclear Masses on Proposed Closed Shells at 20 Nucleons," with W. Low, *Phys. Rev.* **80**, 608 (1950).
38. "Ratio of the Quadrupole Moments of Cl<sup>35</sup> and Cl<sup>37</sup>," with S. Geschwind and R. Gunther-Mohr, *Phys. Rev.* **81**, 288 (1951).
39. "Polarization of the Nucleus by Electric Fields," with R. Gunther-Mohr and S. Geschwind, *Phys. Rev.* **81**, 289 (1951).
40. "The Nuclear Spins and Quadrupole Moments of Stable Germanium Isotopes," with J.M. Mays, *Phys. Rev.* **81**, 940 (1951).
41. "Nuclear Magnetic Moments and Similarity Between Neutron and Proton States in the Nucleus," with A.L. Schawlow, *Phys. Rev.* **82**, 268 (1951).
42. "Determination of Nuclear Properties by Microwave Spectroscopy," *Physica* **17**, 354 (1951).
43. "The Spin of O<sup>18</sup>," with S.L. Miller and A. Javan, *Phys. Rev.* **82**, 454 (1951).
44. "Atomic Clocks and Frequency Stabilization on Microwave Spectral Lines, *J. Appl. Phys.* **22**, 1365 (1951).
45. "Microwave Spectrum and Structure of ReO<sub>3</sub>Cl," with E. Amble, S.L. Miller, and A.L. Schawlow, *J. Chem. Phys.* **20**, 192L (1952).
46. "The Spin and Quadrupole Moment of Se<sup>79</sup>," with W.A. Hardy and G. Silvey, *Phys. Rev.* **85**, 494L (1952).

47. "Nuclear Quadrupole Effects and Electronic Structure of Molecules in the Solid State," with B.P. Dailey, *J. Chem. Phys.* **20**, 35 (1952).
48. "Molecular Microwave Spectra Table," with P. Kisliuk, *N.B.S. Circular No. 518* (1952).
49. "Magnetron Harmonics at Millimeter Wavelengths," with J.A. Klein, J.H.N. Loubser and A.H. Nethercot, *Rev. Sci. Instr.* **23**, 78 (1952).
50. "Charge Distribution in Nuclei from X-ray Fine Structure," with A.L. Schawlow, *Science* **115**, 284 (1952).
51. "Microwave Spectroscopy," *Am. Scientist* **40**, 270 (1952).
52. "The Microwave Spectrum and Molecular Constants of HCN," with A.N. Nethercot, Jr. and J.A. Klein, *Phys. Rev.* **86**, 798L (1952).
53. "Quadrupole Coupling Ratio of the C1 Isotopes," with T.C. Wang, A.L. Schawlow and A.N. Holden, *Phys. Rev.* **86**, 809L (1952).
54. "Microwave Spectroscopy at High Temperature—Spectra of CsCl and NaCl," with M. Stitch and A. Honig, *Phys. Rev.* **86**, 813L (1952).
55. "Structure of the Methyl Halides," with S. Miller, C. Aamodt, G. Dousmanis and J. Kraitchman, *J. Chem. Phys.* **20**, 1112 (1952).
56. "The Present Status of Microwave Spectroscopy," *Ann. N.Y. Acad. Sci.* **55**, 74 (1952).
57. "Spectroscopy Near the Boundary Between the Microwave and Infrared Regions," with A.H. Nethercot, Jr., J.A. Klein, and J.H.N. Loubser, *Nuovo Cimento* **9**, **Suppl. 3**, 358 (1952).
58. "Microwave Spectrum of the Free OH Radical," with T.M. Sanders, Jr., A.L. Schawlow, and G.C. Dousmanis, *Phys. Rev.* **89**, 1158L (1953).
59. "The Microwave Absorption Spectrum of (O<sup>16</sup>)<sub>2</sub> and O<sup>16</sup>O<sup>17</sup>," with S.L. Miller, *Phys. Rev.* **90**, 537 (1953).
60. "The Electronic Structure of O<sub>2</sub>," with S.L. Miller and M. Kotani, *Phys. Rev.* **90**, 542 (1953).
61. "Structure of HNCS from Microwave Spectra," with G.C. Dousmanis, T.M. Sanders, Jr., and H.J. Zeiger, *J. Chem. Phys.* **21**, 1416L (1953).
62. "The Nuclear Moments of Se<sup>79</sup>," with W.A. Hardy, G. Silvey, B.F. Burke, and M.W. Strandberg, *Phys. Rev.* **92**, 1532 (1953).
63. "The Spin of Si<sup>29</sup> and Mass Ratios of the Stable Si Isotopes," with R.L. White, *Phys. Rev.* **92**, 1256 (1953).
64. "Physical and Engineering Applications of Millimeter Waves," *J. Inst. Elec. Com. Engrs. (Japan)* **36**, 650 (1953). (In Japanese)
65. "Recent Contributions of Microwave Spectroscopy to the Study of Molecular Structure," *Symp. Molec. Phys. Nikko* (1953).
66. "Examination of Methods for Detecting OH," with T.M. Sanders, Jr., A.L. Schawlow, and G.C. Dousmanis, *J. Chem. Phys.* **22**, 245 (1954).
67. "The Tendency for Positive Nuclear Quadrupole Moments," with S.A. Moszkowski, *Phys. Rev.* **93**, 306 (1954).
68. "Hyperfine Structure in the Spectrum of N<sup>14</sup>H<sub>3</sub>I. Theoretical Discussion," with R. Gunther-Mohr and J.H. Van Vleck, *Phys. Rev.* **94**, 1191 (1954).
69. "Sulfur Bonds and the Quadrupole Moments of O, S, and Se Isotopes," with G.R. Bird, *Phys. Rev.* **94**, 1203 (1954).
70. "Molecular Microwave Oscillator and New Hyperfine Structure in the Microwave Spectrum of NH<sub>3</sub>," with J.P. Gordon and H.J. Zeiger, *Phys. Rev.* **95**, 282L (1954).
71. "High Temperature Microwave Spectrometer," with M.L. Stitch and A. Honig, *Rev. Sci. Instr.* **25**, 759 (1954).

72. "Determination of Atomic Masses by Microwave Spectroscopy," with S. Geschwind and R. Gunther-Mohr, *Rev. Mod. Phys.* **26**, 444 (1954).
73. "Microwave Spectra of the Alkali Halides," with A. Honig, M. Mandel, and M.L. Stitch, *Phys. Rev.* **96**, 629 (1954).
74. "The Ionic Character of Diatomic Molecules," with B.P. Dailey, *J. Chem. Phys.* **23**, 118 (1955).
75. "Connections Between Molecular Structure and Certain Magnetic Effects in Molecules," with G.C. Dousmanis, R.L. White, and R.F. Schwarz, *Discussions Faraday Soc.* **19**, 56 (1955).
76. "The Maser—New Type of Microwave Amplifier, Frequency Standard, and Spectrometer," with J.P. Gordon and H.J. Zeiger, *Phys. Rev.* **99**, 1264 (1955).
77. "Stark Effect in Rapidly Varying Fields," with S.H. Autler, *Phys. Rev.* **100**, 703 (1955).
78. "Effect on X-ray Fine Structure of Deviations from a Coulomb Field Near the Nucleus," with A. Schawlow, *Phys. Rev.* **100**, 1273 (1955).
79. "Microwave Spectra of the Free Radicals OH and OD," with G.C. Dousmanis and T.M. Sanders, Jr., *Phys. Rev.* **100**, 1735 (1955).
80. "Microwave Spectroscopy," with A.L. Schawlow, McGraw-Hill, New York (1955).
81. "Utilisation de la Resonance de Spins electroniques pour realiser un Oscillateur ou un Amplificateur en Hyperfrequencies," with J. Combrission and A. Honig, *Compt. rend.* **242**, 2451 (1956).
82. "Creation et Amplification de Micro-ondes par Processus atomiques," with J. Combrission, *L'onde Electrique* **36**, 989 (1956).
83. "Discussion of the Present Status and Future of Microwave Physics," with Kotani, Shimoda, Tomonaga, and Yamanouchi, *Kagaku* **26**, 567 (1956).
84. "Developpements recents a propos de la Mesure du Temps," *Arch. des Sci.* **1**, 270 (1956).
85. "Further Aspects of the Theory of the Maser," with K. Shimoda and T.C. Wang, *Phys. Rev.* **102**, 1308 (1956).
86. "On the Interpretation of H.F.S. in Molecules in Terms of Molecular Structure and Nuclear Moments," *Nuovo Cimento Suppl.* **4**, 1201 (1956).
87. "Microwave Spectroscopy," *Recent Advances in Science*, M.H. Shamos and G.M. Murphy (eds.), New York Univ. Press (1956).
88. "Amplification and Generation of Microwaves by Atomic Processes," translated by K. Shimoda, *Proceedings of the Electrical Communication Society of Japan--Denshi-Tsushingakukai Zasshi* **39**, 927 (1956).
89. "Microwave Spectrometer, Amplifier and Oscillator by Stimulated Emission of Radiation," translated by K. Shimoda and H. Takuma, *Nippon Butsurigakukaishi* **12**, 262 (1957).
90. "Fluctuations in Amplification of Quanta with Application to Maser Amplifiers," with K. Shimoda and H. Takahashi, *J. Phys. Soc. Japan* **12**, 686 (1957); also p. 517, Collection of Papers Dedicated to Masao Kotani, Tokyo (1967).
91. "Quadrupole Moment of O<sup>17</sup>," with M.J. Stevenson, *Phys. Rev.* **107**, 635 (1957).
92. "Comments on Frequency-Pulling of Maser Oscillators," *J. Appl. Phys.* **28**, 920 (1957).
93. "Measurements of Noise in a Maser Amplifier," with L.E. Alsop, J.A. Giordmaine and T.C. Wang, *Phys. Rev.* **107**, 1450 (1957).
94. "Acceleration in the Expansion of the Crab Nebula," with F.M. Johnson, *ApJ* **126**, 466 (1957).
95. "Recent Development in Measurement of Time," *Nuovo Cimento* **5**, 222 (1957).

96. "Microwave and Radio-frequency Resonance Lines of Interest to Radio Astronomy," *IAU Symposium No. 4: Radio Astronomy*, H.S. van de Hulst (ed.), 92, Cambridge Univ. Press (1957).
97. "Paramagnetic Relaxation at Very low Temperatures" with J.A. Giordmaine, L.E. Alsop, and F.R. Nash, *Phys. Rev.* **109**, 302 (1958).
98. "Isotopic Mass Ratios, Magnetic Moments and the Sign of the Electric Dipole Moment in Carbon Monoxide," with B. Rosenblum and A.H. Nethercot, Jr., *Phys. Rev.* **109**, 400 (1958).
99. "Recent Determinations of Atomic Mass Ratios by Microwave Spectroscopy," with B. Rosenblum and S. Geschwind, *Rev. Mod. Phys.* **30**, 409 (1958).
100. "New Experimental Test of Special Relativity," with J.P. Cedarholm, G.F. Bland, and B.L. Havens, *Phys. Rev. Lett.* **1**, 342 (1958).
101. Opening Session "Masers," *J. Appl. Phys.* **29**, 238 (1958).
- 101(b) "A Summary of Progress in Maser Development and Some Observations on Paramagnetic Relaxation at Low Temperatures", C.H. Townes, Columbia University, (1958). Publication unknown
102. "Infrared and Optical Masers," with A.L. Schawlow, *Phys. Rev.* **112**, 1940 (1958).
- 102(a) "The Maser – New Type of Microwave Amplifier, Frequency Standard, and Spectrometer", J.P. Gordon, H.J. Zieger, and C.H. Townes, *Phys. Rev.* **99**, 1264-1274 (1955)
103. "Determination of Nuclear Quadrupole Moments," *Handbuch der Physik*, Vol. **38/I**, 377 (1958).
104. "A Maser Amplifier for Radio Astronomy at X-Band," with J.A. Giordmaine, L.E. Alsop, and C.H. Mayer, *Proc. of the IRE* **47**, 1062 (1959).
105. "Ground State L-Doubling Transitions of OH Radical," with G. Ehrenstein and M.J. Stevenson, *Phys. Rev. Lett.* **40** (1959).
106. "A New Experimental Test of Special Relativity," with J.P. Cedarholm, *Nature* **184**, 1350 (1959).
107. "Observations of Discrete Sources at 3-cm Wavelength Using a Maser," with L.E. Alsop, J.A. Giordmaine, and C.H. Mayer, *IAU Symposium No. 9 on Radio Astronomy*, R.N. Bracewell (ed.), 69, Stanford Univ. Press (1959).
108. "Coherent Amplification of Electromagnetic Waves by Atomic and Molecular Phenomena," *Physikertagung Essen* **110** (1959).
109. "Quantum Electronics," C.H. Townes (ed.), Columbia Univ. Press (1960).
110. "Limits on Electromagnetic Amplification Due to Complementarity," with R. Serber, in *Quantum Electronics*, C.H. Townes (ed.), p. 223, Columbia Univ. Press (1960).
111. "Maser," in *Encyclopedia of Science and Technology*, McGraw-Hill (1960).
112. "Sensitivity of Microwave Spectrometers Using Maser Techniques," *Phys. Rev. Lett*, **5**, 428 (1960).
113. "Interstellar and Interplanetary Communication by Optical Masers," with R.N. Schwartz, *Nature* **190**, 205 (April 15, 1961). Also in *Interstellar Communication*, A.G.W. Cameron (ed.), 223, W.A. Benjamin, Inc. (1963).
114. "Mode Characteristics and Coherence in Optical Ruby Masers," with I.D. Abella, *Nature* **192**, 957 (1961).
115. "Some Applications of Optical and Infrared Masers," *Advances in Quantum Electronics*, p. 3, J.R. Singer (ed.), Columbia Univ. Press (1961).
116. "Alkali Vapor Infrared Masers," with H.Z. Cummins, I. Abella, O.S. Heavens, and N. Knable, *Advances in Quantum Electronics*, p. 12, J.R. Singer (ed.), Columbia Univ. Press (1961).
117. "Optical Masers and Their Possible Applications to Biology," *Biophysical Journal*, No. 2, Part 2 (1962).
118. "Masers," *Rendiconti S.I.F.* **17**, 39 (1962).

119. "Comments on 'Noise in Photoelectric Mixing'", with H.A. Haus, *Proceedings of the IRE50*, No. 6 (June 1962).
120. "Introduction to the Principles, Potentialities and Status of Optical and Infrared Masers," *Proc. of the NATO-SADTC Symp. on Technical and Military Applications of Laser Techniques*, p. 7 (1962).
121. "Masers," *The Age of Electronics*, p. 165, Carl F.J. Overhage (ed.), McGraw-Hill Inc. (1962).
122. "Useful Knowledge," *Journal of the Franklin Institute* **274**, No. 6 (December 1962); *Technology Review*, p. 9 (January 1963).
123. "Optical Masers," *Applied Optics Supplement on Optical Masers*, p. A15 (1962).
124. "Frequency Stability of He-Ne Masers and Measurements of Length," with T.S. Jaseja and A. Javan, *Phys. Rev. Lett.* **10**, 165 (1963).
125. "Nuclei as Probes for Determination of Molecular Structure," *Proc. of the Robert A. Welch Found. Conf. on Chemical Research, III. Molecular Structure*, p. 87 (1963).
126. "Coherently Driven Molecular Vibrations and Light Modulation," with E. Garmire and F. Pandarese, *Phys. Rev. Lett.* **11**, 160 (1963).
127. "Optical Masers in Biology and Medicine," with R.A. Malt, *The New England Journal of Medicine* **269**, No. 26 (December 26, 1963).
128. "Test of Special Relativity or of the Isotropy of Space by Use of Infrared Masers," with T.S. Jaseja, A. Javan, and J. Murray, *Phys. Rev.* **133**, A1221 (1964).
129. "Stimulated Brillouin Scattering and Coherent Generation of Intense Hypersonic Waves," with R.Y. Chiao and B.P. Stoicheff, *Phys. Rev. Lett.* **12**, 592 (1964).
130. "Stimulated Brillouin Scattering in Liquids," with E. Garmire, *Appl. Phys. Lett.* **5**, 84 (1964).
131. "Self-Trapping of Optical Beams," with R.Y. Chiao and E. Garmire, *Phys. Rev. Lett.* **13**, 479 (1964).
132. Optical Quantum Electronics "Quantum Electronics and Coherent Light," *Proc. of the Int'l School of Physics "Enrico Fermi,"* P.A. Miles and C.H. Townes (eds.), Academic Press (1964).
133. "Maser Amplification and Coherent Light," Introduction to *Quantum Electronics and Coherent Light, Proc. of the Int'l School of Physics "Enrico Fermi,"* P.A. Miles and C.H. Townes (eds.), Academic Press (1964).
134. "Raman and Phonon Masers," with R.Y. Chiao and E. Garmire, *Quantum Electronics and Coherent Light, Proc. of the Int'l School of Physics "Enrico Fermi,"* p. 326, P.A. Miles and C.H. Townes (eds.), Academic Press (1964).
135. "Production of Coherent Radiation by Atoms and Molecules," *Les Prix Nobel en 1964*, p. 99, Imprimerie Royale, P.A. Norstedt and Soner, Stockholm (1965); *Science* **149**, No. 3686 (August 20, 1965); *IEEE Spectrum* **2**, 30, No. 8 (August 1965); *Umschau* **65**, 489 (August 15, 1965); *Electronique*, No. 54, **359** (October 1965); *Uspekhi Fizicheskikh Nauk* **88**, No. 3 (March 1966); and other journals.
136. "The Theory and Application of Masers and Lasers," *TRW Space Technology Laboratories Lecture Series*, 4 (1965).
137. "Dynamics and Characteristics of the Self-Trapping of Intense Light Beams," with E. Garmire and R.Y. Chiao, *Phys. Rev. Lett.* **16**, 347 (1966).
138. "Manned Extraterrestrial Exploration," *Tech. Engineering News* **47**, 49 (1966); *Science and Math Weekly*, Issue **21** (1966).
139. "The Convergence of Science and Religion," *THINK* **32**, p. 2 (March-April 1966); *Technology Review* **68**, p. 35 (May 1966); *The Christian Science Monitor*, p. 9 (May 7, 1966); and other journals.
140. "Masers," with H.J. Zeiger, *The Encyclopedia Americana* Vol. **18**, p. 368 (1966).

141. "The Interaction of Intense Light Waves and Mechanical Motions in Extended Media," with R.Y. Chiao and E. Garmire, *Some Recent Advances in the Basic Sciences*, p. 91, A. Gelbart (ed.), Academic Press (1966).
142. "6 A 1- A New Class of Trapped Light Filaments," with R.Y. Chiao, M.A. Johnson, S. Krinsky, H.A. Smith, and E. Garmire, *J. Quantum Electron.* Vol. **QE-2**, No. 9, 467 (1966).
143. "A Portentous Decade for Optics," *New Scientist* **32**, No. 522, 429 (1966).
144. "Standing Waves in Self-Trapped Light Filaments," with R.G. Brewer, *Phys. Rev. Lett.* **18**, 196 (1967).
145. "Self-Steepening of Light Pulses," with F. DeMartini, T.K. Gustafson, and P.L. Kelley, *Phys. Rev.* **164**, 312 (1967).
146. "Quantum Electronics and Surprise in Development of Technology, The Problem of Research Planning," *Science* **159**, 699 (1968); *Science in America, Historical Selections*, p. 474, John C. Burnham (ed.), Holt, Rinehard and Winston, Inc. (1971).
147. "Small-Scale Trapped Filaments in Intense Laser Beams," with R.G. Brewer, J.R. Lifshitz, E. Garmire, and R.Y. Chiao, *Phys. Rev.* **166**, 326 (1968).
148. "Phase Modulation of Q-Switched Laser Beams in Small-Scale Filaments," with A.C. Cheung, D.M. Rank, and R.Y. Chiao, *Phys. Rev. Lett.* **20**, 786 (1968).
149. "Anti-Stokes Generation in Trapped Filaments of Light," with C.A. Sacchi and J.R. Lifshitz, *Phys. Rev.* **174**, 439 (1968).
150. "Detection of NH<sub>3</sub> Molecules in the Interstellar Medium by Their Microwave Emission," with A.C. Cheung, D.M. Rank, D.D. Thornton, and W.J. Welch, *Phys. Rev. Lett.* **21**, 1701 (1968).
151. "The Role of Science in Modern Education," *The Southern Baptist Educator* **33**, 5 (1969).
152. "Detection of Water in Interstellar Regions by Its Microwave Radiation," with A.C. Cheung, D.M. Rank, D.D. Thornton, and W.J. Welch, *Nature* **22**, 626 (1969).
153. "Spectra, Variability, Size, and Polarization of H<sub>2</sub>O Microwave Emission Sources in the Galaxy," with S.H. Knowles, C.H. Mayer, A.C. Cheung, and D.M. Rank, *Science* **163**, 1055 (1969).
154. "Further Microwave Emission Lines and Clouds of Ammonia in our Galaxy," with A.C. Cheung, D.M. Rank, and W.J. Welch, *Nature* **221**, 917 (1969).
155. "Frequency Conversion and Detection of Infrared Radiation," with H.A. Smith, *Polarisation, Matiere et Rayonnement*, p. 467, Jubilee Volume Honor of Alfred Kastler, Presses Universitaires de France (1969).
156. "Distribution of Ammonia Density, Velocity, and Rotational Excitation in the Region of Sagittarius B2," with A.C. Cheung, D.M. Rank, S.H. Knowles, and W.T. Sullivan, III, *ApJ Lett.* **157**, L13 (1969).
157. "A Pumping Mechanism for Anomalous Microwave Absorption in Formaldehyde in Interstellar Space," with A.C. Cheung, *ApJ Lett.* **157**, L13 (1969).
158. "Quantum Optics or Quantum Electronics," *Contemporary Physics* **1**, *Proc. Int'l Symp. on Contemporary Physics*, p. 294, International Atomic Energy Agency, Vienna (1969).
159. "A Search for the 10-11 Transition of Interstellar H<sub>2</sub>CS," with N.J. Evans, II, H.F. Weaver, and D.R.W. Williams, *Science* **169**, 680 (1970).
160. "Detection of 10.5 Micron Line Emission from the Planetary Nebula NGC 7027," with D.M. Rank, J.Z. Holtz, and T.R. Geballe, *ApJ Lett.* **161**, L185 (1970).
161. "The Intersection of Quantum Electronics and Astrophysics," *Oyo Buturi* **40**, No. 5:2 (1971).
162. "Maser," *McGraw-Hill Encyclopedia of Science and Technology*, p. 203 (1971).
163. "Microwave Evidence for Interstellar Molecules," *Highlights of Astronomy*, p. 359, C. DeJager (ed.), D. Reidel Publishing Company (1971).
164. "Interstellar Molecules and Dense Clouds," with D.M. Rank and W.J. Welch, *Science* **174**, 1083 (1971).

165. "How and Why Did It All Begin?," *Journal of the American Scientific Affiliation* **24**, 1,1 (1972).
166. "Influence of Steric Effects and Compressibility on Nonlinear Response to Laser Pulses and the Diameters of Self-Trapped Filaments," with T.K. Gustafson, *Phys. Rev. A* **4**, p. 1659 (1972).
167. "Differentiation and Competition Between University and Other Research Laboratories in the United States," *Daedalus, Proc. American Academy of Arts and Science* **102**, 2, 153 (1973).
- 168.m. "Opportunities in Astrophysics," Guest Editorial, *Physics Today* (March, 1973).
169. "Nonequilibrium Distributions of Molecular States in Interstellar Space," *Fundamental and Applied Laser Physics: Proceedings of the Esfahan Symposium*, August 29-September 5, 1971, John Wiley & Sons, Inc. (1973).
170. "Ammonia in Dark Interstellar Clouds," with A.C. Cheung, M.D. Chui, D. Matsakis, and K.S. Yngvesson, *ApJ Lett.* **186**, L73 (1973).
171. "The Methanol Source in Orion at 1.2 Centimeters," with M.F. Chui, A.C. Cheung, D. Matsakis, and A.G. Cardiasmenos, *ApJ Lett.* **187**, L19 (1974).
172. "Isotopic Abundances and Their Variations Within the Galaxy," with M. Bertojo and M.F. Chui, *Science* **184**, No. 4137, 619 (1974).
173. "Infrared Pumping Processes for SiO Masers," with T.R. Geballe, *ApJ Lett.* **191**, L37 (1974).
174. "An Upper Limit on the Evolution of Carbon Monoxide from Comet Kohoutek," with E.R. Wollman, T.R. Geballe, L.T. Greenberg, J.H. Lacy, and D.M. Rank, *Icarus* **23**, 599 (1974).
175. "10  $\mu\text{m}$  Heterodyne Stellar Interferometer," with M.A. Johnson and A.L. Betz, *Phys. Rev. Lett.* **33**, 1617 (1974).
176. "Observations and Analysis of the Jovian Spectrum in the 10-Micron  $\text{V}_2$  Band of  $\text{NH}_3$ ," with J.H. Lacy, A.I. Larrabee, E.R. Wollman, T.R. Geballe, J.D. Bregman, and D.M. Rank, *ApJ Lett.* **198**, L145 (1975).
177. "High-Resolution Astronomy Between Three Microns and Three Millimeters," *Rank Prize Funds' Symposium on Very High Resolution Spectroscopy*, R.A. Smith (ed.), Chapter 9, 159, Academic Press (1976).
178. "Interstellar Molecules," *Memoires Societe Royale des Sciences de Liege*, 63 series, tome **IX**, 453 (1976).
179. "Spectral and Spatial Resolution of the 12.8 Micron NeII Emission from the Galactic Center," with E.R. Wollman, T.R. Geballe, J.H. Lacy, and D.M. Rank, *ApJ Lett.* **205**, L5 (1976).
180. "Observations of the  $^{12}\text{C}/^{13}\text{C}$  Ratio in Four Galactic Sources of Formaldehyde," with D.N. Matsakis, M.F. Chui, and P.F. Goldsmith, *ApJ Lett.* **206**, L63 (1976).
181. "Nonthermal 10 Micron  $\text{CO}_2$  Emission Lines in the Atmospheres of Mars and Venus," with M.A. Johnson, A.L. Betz, R.A. McLaren, and E.C. Sutton, *ApJ Lett.* **208**, L145 (1976).
182. "Collisional Excitation of  $\Lambda$  Doublet Transitions in CH and OH," with M. Bertojo and A.C. Cheung, *ApJ* **208**, 914 (1976).
183. "The Challenge of Astronomy to Millimeter Wave Technology," *IEEE Trans. Microwave Theory Tech.* Vol. MTT-**24**, No. 11, 709 (1976).
184. "K-Band Traveling-Wave Maser Using Ruby," with K.S. Yngvesson, A.C. Cheung, M.F. Chui, A.G. Cardiasmenos, and S.Y. Wang, *IEEE Trans Microwave Theory Tech.* Vol. MTT-**24**, No. 11, 709 (1976).
185. "Observation of the  $J = 5 \rightarrow 6$  Rotational Spectrum of  $\text{NH}_3$  in Jupiter, and its Comparison with Expectation from Model Atmospheres," with L. Greenberg, R. McLaren, and L. Stoller, *NASA Technical Memorandum NASA TMX-73*, 190, Symposium on Recent Results in Infrared Astrophysics, Ames Research Center, Palmer Dyal (ed.), (1977).
186. "Interstellar Molecules," (Halley Lecture). *The Observatory* **97**, 52 (1977).



187. "Isotopic Abundances in Interstellar Clouds," *Proc. IAU Commission 34*, **Vol. 30**, 113, 1976, Topics in Interstellar Matter, Hugo Van Woerden (ed.), Astrophysics and Space Science Library, D. Reidel Publ. Co. (1977).
188. "An Infrared Upconverter for Astronomical Imaging," with R.W. Boyd, *Appl. Phys. Lett.* **Vol. 31**, No. 7, 440 (1977).
189. "Spatial Heterodyne Interferometry of VY Canis Majoris, Alpha Orionis, Alpha Scorpii, and R. Leonis at 11 Microns," with E.C. Sutton, J.W.V. Storey, A.L. Betz, and D.L. Spears, *ApJ Lett.* **271**, L97 (1977).
190. "Isotopic Abundances in Our Galaxy of the More Common Elements," *Proc. R.A. Welch Foundation Conference on Chemical Research, XXI. Cosmochemistry*, W.O. Milligan (ed.), 280 (1977).
191. "Ne II 12.8 Micron Emission from the Galactic Center II," with E.R. Wollman, T.R. Geballe, J.H. Lacy, and D.M. Rank, *ApJ Lett.* **218**, L103 (1977).
192. "A Sensitive Infrared Imaging Upconverter and Spatial Coherence of Atmospheric Propagation," with R.W. Boyd, *Proc. 4th Rochester Conference, Coherence and Quantum Optics IV*, L. Mandel and E. Wolf (eds.), 333, Plenum Publishing, New York (1978).
193. "Infrared Heterodyne Interferometry," with E.C. Sutton and J.W.V. Storey, *ECO Conference Proceedings, Optical Telescopes of the Future*, 409, Geneva (1977).
194. "The Laser's Roots--Townes Recalls the Early Days," Charles H. Townes, *Laser Focus*, 52, August 1978.
195. "Variations in the Spatial Distribution of 11 Micron Radiation from Omicron Ceti," with E.C. Sutton, J.W.V. Storey, and D.L. Spears, *ApJ Lett.* **224**, L123 (1978).
196. "Ne II 12.8 Micron Emission and Galactic Dynamics in M82," with S.C. Beck, J.H. Lacy, and F. Baas, *ApJ* **226**, 545 (1978).
197. "Observations of the Motion and Distribution of the Ionized Gas in the Central Parsec of the Galaxy," with J.H. Lacy, F. Baas, and T.R. Geballe, *ApJ Lett.* **227**, L17 (1979).
198. "Invited Summary," *IAU Colloquium No. 50*, J. David and W.J. Tango (eds.), Chatterton Astronomy Department, University of Sydney, 35 (1979).
199. "Infrared Heterodyne Spectroscopy for Astronomical Purposes," *Proc. 2nd International Conference on Infrared Physics (CIRP2)*, 152, Zurich (1979).
200. "New experimental possibilities and the future--far IR," *Proc. IAU Symposium No. 87*, Mont Tremblant, Canada (1979).
201. "Observations of far-infrared fine structure lines: [O III] 88.35 microns and [O I] 63.2 microns," with J.W.V. Storey and D.M. Watson, *ApJ* **233**, 109 (1979).
202. "Ammonia observations of the Orion Molecular Cloud," with P.T.P. Ho, A.H. Barrett, P.C. Myers, D.N. Matsakis, A.C. Cheung, M.F. Chui, and K.S. Yngvesson, *ApJ* **234**, 912 (1979).
203. "Infrared imaging and interferometry," *Proc. Optical and Infrared Telescopes for the 1990's*, Tucson, Arizona (1980).
204. "An interferometric and multitransitional study of the Orion methanol masers," with D.N. Matsakis, A.C. Cheung, M.C.H. Wright, J.A. Askne, and W.J. Welch, *ApJ* **236**, 481 (1980).
205. "An Airborne Far-infrared Spectrometer for astronomical observations," with J.W.V. Storey and D.M. Watson, *Int'l of IR and mm Waves*, **Vol. 1**, 15 (1980).
206. "Detection of CO J = 21 → 20 (124.2 μm) and J = 22 → 21 (118.6 μm) emission from the Orion Nebula," with D.M. Watson, J.W.V. Storey, E.E. Haller, and W.L. Hansen, *ApJ Lett.* **239**, L129 (1980).
207. "Far-infrared [O III] line emission from the Galactic Center," with D.M. Watson and J.W.V. Storey, *ApJ* **241**, L43 (1980).

208. “Observations of the motion and distribution of the ionized gas in the central parsec of the Galaxy.II,” with J.H. Lacy, T.R. Geballe, and D.J. Hollenbach, *ApJ* **241**, 132 (1980).
209. “Ammonia observations of DR21, W51, NGC 1333, and other sources,” with D.N. Matsakis, J.M. Bologna, P.R. Schwartz, and A.C. Cheung, *ApJ* **241**, 655 (1980).
210. “New experimental possibilities and the future of far IR wavelengths,” B.H. Andrew (ed.), *Interstellar Molecules* **637**, IAU (1980).
211. “Detection of interstellar OH in the far-infrared,” with J.W.V. Storey and D.M. Watson, *ApJ Lett.* **244**, L27 (1981).
212. “Far-infrared observations of shocked CO in Orion,” with J.W.V. Storey and D.M. Watson, *ApJ* **247**, 136 (1981).
213. “Multiple telescope Infrared Interferometry,” with E.C. Sutton, *ESO Conference Proceedings on Scientific Importance of High Angular Resolution at Infrared and Optical Wavelengths*, p. 199, M.H. Ulrich and K. Kjar (eds.), Garching (1981).
214. “Detection of [0 I] 63 micron emission from the Galactic Center,” with D.F. Lester, M.W. Werner, J.W.V. Storey, and D.M. Watson, *ApJ Lett.* **248**, L109 (1981).
215. “The abundances of neon, sulfur, and argon in planetary nebulae,” with S.C. Beck, J.H. Lacy, L.H. Aller, T.R. Geballe, and F. Baas, *ApJ* **249**, 592 (1981).
216. “VLA observations of DR21  $\text{HN}_3(1,1)$  absorption: direct evidence for clumping,” with D.N. Matsakis, A. Hjalmarson, P. Palmer, and A.C. Cheung, *ApJ Lett.* **250**, L85 (1981).
217. “Far-Infrared [0 III] and [N III] line emission from Galactic H II regions and planetary nebulae,” with D.M. Watson, J.W.V. Storey, and E.E. Hall, *ApJ* **250**, 605 (1981).
218. “Messages from molecules in interstellar space,” in *Dansk Ingeniorforening*, p. 14, Lecture given October 4, 1979 for Niels Bohr International Gold Medal (1979).
219. “High spectral and spatial resolution observations of the 12 micron emission from  $\text{H}_2$  in the Orion Molecular Cloud,” with S.C. Beck, E.E. Bloemhof, E. Serabyn, A.T. Tokunaga, J.H. Lacy, and H.A. Smith, *ApJ Lett.* **253**, L83 (1982).
220. “Interferometric measurements of stellar positions in the infrared,” with E.C. Sutton and S. Subramanian, *Astron. Astrophys.* **110**, 324 (1982).
221. “OI and O III in Sgr A: neutral and ionized gas at the Galactic Center,” with R. Genzel, D. Watson, J. Storey, D. Lester, H. Dinerstein, and M. Werner, in *AIP Conference Proceedings No. 83, The Galactic Center*, p. 72, California Institute of Technology, G.R. Riegler and R.D. Blandford (eds.), AIP (1982).
222. “The nature of the central parsec of the galaxy,” with J.H. Lacy and D.J. Hollenbach, *ApJ* **262**, 120 (1982).
223. “Small rotating clouds of stellar mass in Orion Molecular Cloud 1,” with A. Harris, D.M. Matsakis, and P. Palmer, *ApJ Lett.* **265**, L63 (1983).
224. Lecture given as a member of the “Distinguished Scientist Panel,” in *Proceedings of the Fourteenth Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting*, p. 641, NASA Conference Publication 2265 (1983).
225. “The Centre of the Galaxy,” C.H. Townes, J.H. Lacy, T.R. Geballe, and D.J. Hollenbach, *Nature* **301**, 661 (1983).
226. “Detection of interstellar  $\text{NH}_3$  the far-infrared: warm and dense gas in Orion-KL,” with R. Genzel, D. Watson, and J. Storey, *ApJ Lett.* **269**, L11 (1983).
227. “Interstellar ammonia,” with P.T.P. Ho, *Ann. Rev. Astron. Astrophys.* **21**, 239 (1983).
228. “Science, technology, and invention: Their progress and interactions,” *Proc. Natl. Acad. Sci. USA* **80**, p. 7679 (1983).

229. "At what wavelengths should we search for signals from extraterrestrial intelligence?" *Proc. Natl. Acad. Sci.* **80**, 1147 (1983).
230. "Harnessing light", *Science* **84**, Vol. 5, No. 9 (November), p. 153 (1984).
231. "Diffraction-limited spatial resolution of circumstellar dust shells at 10 microns," with E. Bloemhof and A.H.B. Vanderwyck, *ApJ* **276**, L21 (1985).
232. "Far-infrared spectroscopy of the galactic center: neutral and ionized gas in the central 10 parsecs of the galaxy," with R. Genzel, D.M. Watson, H.L. Dinerstein, D. Hollenbach, D. Lester, M. Werner, and J.W.V. Storey, *ApJ* **276**, 551 (1984).
233. "Detection of far-infrared [OI] and [O III] emission from the Galaxy M82," with D.M. Watson, R. Genzel, M.W. Werner, and J.W.V. Storey, *ApJ* **279**, L1 (1984).
234. "Spatial interferometry in the mid-infrared region," *J. Astrophys. & Astron.* **5**, 111 (1984).
235. "Ideas and stumbling blocks in quantum electronics," *IEEE J. Quantum Elec.* **QE-20**, 547 (1984).
236. "A conversation with Charles Townes," *Lasers & Applications Magazine* **4**, 65 (January 1985).
237. "Far-infrared spectroscopy of galaxies: The 158  $\mu\text{m}$  C<sup>+</sup> line and the energy balance of molecular clouds," with M.K. Crawford, R. Genzel, and D.M. Watson, *ApJ* **291**, 755 (1985).
238. "Mass distribution in the galactic center," with M.K. Crawford, R. Genzel, A.I. Harris, D.T. Jaffe, J.H. Lacy, J.B. Lugten, and E. Serabyn, *Nature* **315**, 467 (1985).
239. "The neutral-gas disk around the galactic center," with R. Genzel, D.M. Watson, and M.K. Crawford, *ApJ* **297**, 766 (1985).
240. "Optical path length fluctuations in the atmosphere," with G.N. Gibson, J. Heyman, J. Lugten, and W. Fitelson, *Appl. Optics* **23**, 4383 (1984).

**#241 & 242 combined in one drawer**

241. "Detection of shocked atomic gas in the Kleinmann-Low Nebula," with M.W. Werner, M.K. Crawford, R. Genzel, D.J. Hollenbach, and D.M. Watson, *ApJ* **28**, L81 (1984).
242. "Far-infrared emission lines of CO and OH in the Orion-KL molecular shock," with D.M. Watson, R. Genzel, and J.W.V. Storey, *ApJ* **298**, 316 (1985).
243. "Technology and the nuclear weapons impasse," *Bohemian Club Library Notes* No. 48 (1985).
- 244(a). "Rapid variation in the circumstellar 10 micron emission of  $\alpha$  Orionis," with E.E. Bloemhof, and W.C. Danchi, *ApJ (Lett)*. **299**, L37 (1985).
- 244(b). "10  $\mu\text{m}$  array imaging of circumstellar dust," *Cool Stars, Stellar Systems, and the Sun, Lecture Notes in Physics* **254**, 448, Proc. Fourth Cambridge Wkshp., Sante Fe, October 1985. M. Zeilik, D.M. Gibson (eds), Springer-Verlag, New York (1986).
245. "Long Baseline Spatial Interferometer for the Infrared," with W.C. Danchi, B. Sadoulet and E.C. Sutton, *Advanced Technology Optical Telescope III*, Larry D. Barr (ed), *Proc. SPIE* **628**, 281 (1986).
246. "A high precision telescope pointing system," with W.C. Danchi, A. Arthur, R. Fulton, M. Peck, B. Sadoulet, E.C. Sutton, and R.H. Weitzmann, *Advanced Technology Optical Telescope III*, Larry D. Barr (ed), *Proc. SPIE* **628**, 422 (1986).
247. "Collision cross-sections for ammonia in its ground vibrational manifold," with A. Das, *J. Chem. Phys.* **85** (July 1986).

**#248, 249 & 250 combined in one drawer**

248. "Excitation gradient of the molecular gas in the Sgr A circum-nuclear ring," with J.B. Lugten, G.J. Stacey, A.I. Harris, and R. Genzel, *The Galactic Center, AIP Conference Proceedings*, 155, D.C. Baker (ed.), (1986).

249. “Mapping of C<sup>+</sup> far-infrared emission in the inner galaxy,” with J.B. Lugten, R. Genzel, and M.K. Crawford, *The Galactic Center, AIP Conference Proceedings*, 155, D.C. Baker (ed.), (1986).
250. “The possibilities of expanding technology,” *Electrical Engineering: The Second Century Begins*, A. Freitag (ed.), IEEE Press (1986).
251. “[C II] 158  $\mu$ m mapping in Sgr A: rotation curve and mass distribution in the center of the galaxy,” with J.B. Lugten, R. Genzel, and M.K. Crawford, *ApJ* **306**, 691 (1986).
252. “Quantum electronics at Columbia University,” *Proceedings of the Fortieth Anniversary Symposium of the Joint Services Electronics Program (JSEP)*, (January 1987).
253. “Physical conditions, dynamics and mass distribution in the galactic center” R. Genzel and C.H. Townes, *Ann. Rev. Astron. Astrophys.* **25**, 377 (1987).
- 254(a). “Detection of molecular spectra,” Alan H. Barrett, Lewis E. Snyder, Charles H. Townes, and W. Jack Welch, Letters to the Editor, *Science* **238**, 133 (1987).
- 254(b). “Science, values, and beyond,” *Synthesis of Science and Religion*, (T.D. Singh and Ravi Gomatam (eds.), m. p. 140, The Bhaktivedanta Institute (1988).
255. “High-resolution [Ne II] observations of the ionized filaments in the Galactic Center,” E. Serabyn, J.H. Lacy, C.H. Townes, and R. Bharat, *ApJ* **326**, 171 (1988).

**#256 & 257 combined in one drawer**

- 256(a). “The U.C. Berkeley Infrared Heterodyne Interferometer,” W.C. Danchi, M. Bester, and C.H. Townes, *High Resolution Imaging by Interferometry*, Fritz Merkle (ed.), ESO Conference and Workshop Proceedings No. **29**, 867, European Southern Observatory, Munich, Germany (1988).
- 256(b). “Long Baseline IR Interferometry,” with M. Bester and W.C. Danchi, Proceedings of the *Fourth International Conference on Infrared Physics*, Zurich, Switzerland, August 11-26, 1988.
- 256(c). “Long-Baseline Infrared Spatial Interferometry,” *Optical Society of America Annual Meeting, 1988 Technical Digest Series*, **Vol. 11** (Optical Society of American, Washington, DC (1988).
257. “Foreign-gas collision broadening of the far-infrared spectrum of water vapor,” Samuel D. Gasster, Charles H. Townes, David Goorvitch, and Francisco P.J. Valero, *Journal of the Optical Society of America*, **5**, 593 (1988).
258. “High spatial resolution 10 micron imaging of IRC+10216,” E.E. Bloemhof, W.C. Danchi, C.H. Townes, and R.A. McLaren, *Ap.J.* **333**, 300 (1988).
259. “On science, and what it may suggest about us,” *Theological Education*, a publication of the Association of Theological Schools **25**, 1, 7 (1988).
260. “The Galactic Center - Introductory review: Outstanding puzzles and challenges,” in the *Proceedings of the Galactic Center, IAU Symposium No. 136*, M. Morris and J.E. Beckman (eds.), *The Center of the Galaxy*, 1, IAU (1989).

**#261 & 262 combined in one drawer**

261. “ISI, a long-baseline Infrared Spatial Interferometry,” M. Bester, W.C. Danchi, and C.H. Townes, *Optical Society of America Annual Meeting, 1988, Technical Digest Series*, Vol. **11** (1988).
262. “The Galactic Center,” in *Evolutionary Phenomena in Galaxies*, University of Cambridge Press (1988).
- 263(a). “Submillimeter and far-infrared observations of photodissociation regions: A detailed study of M17 SW,” A.I. Harris, J. Stutzki, J. Herman, R. Genzel, D.T. Jaffe, J.B. Lugten, G.J. Stacey, and C.H. Townes, *Molecular Clouds in the Milky Way and External Galaxies*, J. Young (ed.), Springer-Verlag (1988).
- 263(b). “A variable baseline Infrared Spatial Interferometer and a precision visibility curve of IRC+10216,” M. Bester, W.C. Danchi, and C.H. Townes, *Bull. of Amer. Astr. Soc.* **21**, 1137 (1989).

**#264 & 265 combined in one drawer**

264. "Infrared Long Baseline Interferometry," W.C. Danchi, M. Bester, P.R. McCullough, and C.H. Townes, *Highlights of Astronomy*, D. McNully (ed.), **8**, 563, D. Reidel, Dordrecht (1989).
265. "158  $\mu\text{m}$  [C II] mapping of the galactic center molecular clouds," R. Genzel, G.J. Stacey, C.H. Townes, A. Poglitsch, and N. Geis, *IAU Symposium No. 136: The Galactic Center*, M. Morris (ed.), 151 (1989).

**#266 & 267 combined in one drawer**

266. "[C II] line emission from spiral galaxies," G.J. Stacey, R. Genzel, J.B. Lugten, and C.H. Townes, *The Physics and Chemistry of Interstellar Molecular Clouds*, G. Winnewisser and J.T. Armstrong (eds.), Springer-Verlag (1989)
267. "Recent astronomical results from the Infrared Spatial Interferometer and their implications for a lunar optical/IR interferometer," W.C. Danchi, M. Bester, and C.H. Townes, in the *NASA Confer. Publication of the Workshop on the Lunar Optical/IR Synthesis Array*, University of New Mexico, Albuquerque, NM (February 1989).
268. "The U.C. Berkeley Infrared Spatial Interferometer: instrumentation and first results," M. Bester, W.C. Danchi, P.R. McCullough, and C.H. Townes, in *Lecture Notes in Physics* **331**, 396, Springer, Heidelberg (1989).
269. "Atmospheric transmission in the far-infrared at the South Pole and astronomical applications," Charles H. Townes and Gary Melnick, *Publications of the Astronomical Society of the Pacific* **102**, 357 (1990).
270. "Openness in military affairs," Charles H. Townes, *The Challenge of an Open World: Essays Dedicated to Niels Bohr*, N. Barfoed, T. Bredsdorff, L. Christensen, and O. Nathan (eds.), p. 52, University of Copenhagen (1989).
271. "Spatially resolved dust around IRC+10420," E.E. Bloemhoff, W.C. Danchi, and C.H. Townes, *Proceedings of the Sixth Cambridge Workshop on Cool Stars, Stellar Systems and the Sun* (Astron. Soc. of the Pac.) G. Wallerstein (ed.) **102**, 387 (1989).
272. "Discovery of the laser," Charles H. Townes, *Ophthalmic Lasers: A Second Generation*, Wayne F. March (ed.), SLACK, Inc., p. 1 (1990).
273. "Long baseline interferometer for the mid-infrared," M. Bester, W.C. Danchi, and C.H. Townes, *Amplitude and Intensity Spatial Interferometry*, J.B. Breckinridge (ed.), *Proc. SPIE*, **1237**, 40 (1990).
274. "Visibility curves at 10  $\mu\text{m}$  wavelength for stars and dust shells," W.C. Danchi, M. Bester, C. Degiacomi, P.R. McCullough, and C.H. Townes, *Amplitude and Intensity Spatial Interferometry*, J.B. Breckinridge (ed.), *Proc. SPIE*, **1237**, 327 (1990).
275. "The Galactic Center," Charles H. Townes, *Proceedings of Astrophysics and Infrared Arrays*, Tucson, AZ, February 1990.
276. "What is happening at the center of our galaxy?," Charles H. Townes and Reinhard Genzel, *Scientific American* **262**, 4, April 1990.
277. "Far-infrared, submillimeter, and millimeter spectroscopy of the galactic center: radio arc and + 20/ + 50 kilometer per second clouds," R. Genzel, G.J. Stacey, A.I. Harris, C.H. Townes, N. Geis, U.U. Graf, A. Poglitsch, and J. Stutzki, *ApJ* **356**, 160 (1990).
278. "Location and phase of dust formation in IRC +10216 indicated by 11 micron spatial interferometry," W.C. Danchi, M. Bester, C.G. Degiacomi, P.R. McCullough, and C.H. Townes, *ApJ Lett.* **359**, L59 (1990).
279. "Imaging Triple-Fabry-Pérot Spectrometer for Far-infrared Astronomy," A. Poglitsch, N. Geis, M. Haggerty, R. Genzel, G. Stacey, and C. Townes, *Submillimeter Astronomy*, G.D. Watt and A.S. Webster (eds.), Kluwer Academic 67-68 (1990).

280. “Response to the message of John Paul II,” in *John Paul II on Science and Religion: Reflections on the New View from Rome*, R Russell, W. Stoeger, G. Coyne (eds.), Vatican Observatory Publications, The Univ. of Notre Dame Press (1990).
281. “Distribution of dust about  $\alpha$  Ceti and  $\alpha$  Orionis based on 11 micron spatial interferometry,” M. Bester, W.C. Danchi, C.G. Degiacomi, C.H. Townes, and T.R. Geballe, *ApJ Lett.* **367**, L27 (1991).

**#282 & 283 combined in one drawer**

282. “158  $\mu\text{m}$  [C II] line emission from galaxies,” G.J. Stacey, R. Genzel, J.B. Lugten, and C.H. Townes, *Submillimeter and Millimeter Wave Astronomy*, G.D. Watt and A.S. Webster (eds.), Kluwer Academic **125** (1990).
283. “Automation of interferometric observations,” M. Bester, C.G. Degiacomi, W.C. Danchi, L.J. Greenhill, and C.H. Townes, in *Robotic Telescopes in the 1990s*, A.V. Filippenko (ed.), ASP Conf. Series **34**, 213 (1992).
284. “The 158 micron [C II] line: A measure of global star formation activity in galaxies,” G.J. Stacey, N. Geis, R. Genzel, J.B. Lugten, A. Poglitsch, A. Sternberg, and C.H. Townes, *ApJ* **373**, 423 (1991).

**#285 & 285 combined in one drawer**

285. “[C II] 158  $\mu\text{m}$  line mapping of spiral galaxies,” G.J. Stacey, N. Geis, R. Genzel, J.M. Jackson, A. Poglitsch, and C.H. Townes, *Proceedings of the 29<sup>th</sup> Liege International Astrophysical Colloquium: From Ground-based to Space-borne Sub-mm Astronomy*, B.H. Kaldeich (ed.), ESA, SP-314, 85 (1991).
286. “Advances in Science,” Charles Townes, *The Commonwealth*, p. 169 (1991).

**#287 & 288 combined in one drawer**

287. “A survey of the 158  $\mu\text{m}$  [C II] fine-structure line in the central 50 parsecs of the galaxy,” A. Poglitsch, G.J. Stacey, N. Geis, M. Haggerty, J. Jackson, M. Rumitz, R. Genzel, and C.H. Townes, *ApJ Lett.* **374**, L33 (1991).
288. “The optical depth of the 158 micron [<sup>12</sup>C II] line: Detection of the F = 1  $\rightarrow$  0 [<sup>13</sup>C II] hyperfine-structure component,” G.J. Stacey, C.H. Townes, A. Poglitsch, S.C. Madden, J.M. Jackson, F. Herrmann, R. Genzel, and N. Geis, *ApJ Lett.* **382**, L37 (1991).

**#289 & 290 combined in one drawer**

- \*289. “The MPE/UCB Far-infrared Imaging Fabry-Pérot Interferometer (FIFI),” A. Poglitsch, J.W. Beeman, N. Geis, R. Genzel, M. Haggerty, E.E. Haller, J. Jackson, M. Rumitz, C.H. Townes, and G.J. Stacey, *Proc. 29th International Astrophys. Colloquium, ESA SP-314* (December 1990).
- \*290. “The MPE/UCB Far-infrared Imaging Fabry-Pérot Interferometer (FIFI),” A. Poglitsch, J.W. Beeman, N. Geis, R. Genzel, M. Haggerty, E.E. Haller, J. Jackson, M. Rumitz, C.H. Townes, and G.J. Stacey, *Internat. J. Infrared Millimeter Waves*, **12**, 859 (1991).
291. “Atmospheric fluctuations: empirical structure functions and projected performance of future instruments,” M. Bester, W.C. Danchi, C.G. Degiacomi, L.J. Greenhill, and C.H. Townes, *ApJ* **392**, 357 (1992).
292. “Heating of H II regions with application to the Galactic Center,” Philip R. Maloney, David A. Hollenbach, and Charles H. Townes, *ApJ* **401**, 559 (1992).
293. “Neutral gas in the central 2 parsecs of the galaxy,” J.M. Jackson, N. Geis, R. Genzel, A.I. Harris, S. Madden, A. Poglitsch, G. Stacey, and C. H. Townes, *ApJ* **402**, 173 (1993).
294. “158 micron [C II] mapping of the Orion Molecular Cloud,” G.J. Stacey, D.T. Jaffe, N. Geis, R. Genzel, A.I. Harris, A. Poglitsch, J. Stutzki, and C.H. Townes, *ApJ* **404**, 219 (1993).

295. “158 micron [C II] mapping of NGC 6946: Probing the atomic medium,” S.C. Madden, N. Geis, R. Genzel, F. Herrmann, J. Jackson, A. Poglitsch, G.J. Stacey, and C.H. Townes, *ApJ* **407**, 579 (1993).
296. “Analysis of atmospheric fluctuations and their implications for high resolution astronomy,” M. Bester, W.C. Danchi, C.G. Degiacomi, L.J. Greenhill, and C.H. Townes, in *High Resolution Imaging by Interferometry II*, J.M. Beckers and F. Merkle (eds.), ESO Conference and Workshop Proceedings, **39**, 1017 (1992).
297. “Observations of circumstellar dust shells with a long baseline interferometer at 11  $\mu\text{m}$ ,” C.G. Degiacomi, M. Bester, W.C. Danchi, L.J. Greenhill, and C.H. Townes, in *High Resolution Imaging by Interferometry II*, J.M. Beckers and F. Merkle (eds.), ESO Conference and Workshop Proceedings, **39**, 681 (1992).
298. “New technical developments at the infrared spatial interferometer,” L.J. Greenhill, M. Bester, W.C. Danchi, C.G. Degiacomi, and C.H. Townes, in *High Resolution Imaging by Interferometry II*, J.M. Beckers and F. Merkle (eds.), ESO Conference and Workshop Proceedings **39**, 721 (1992).
299. “Reflections on my life as a physicist,” Charles H. Townes, *Center for Theology and Natural Sciences Bulletin* **12**, No. 3 (1992).
300. “The early years of research on astronomical masers,” Charles H. Townes, *Astrophysical Masers*, Proceedings of a Conference in Arlington, VA, March 9-11, 1992, Springer, Andrew W. Clegg and Gerald E. Nedoluha (eds.), 3 (1993).
301. “How the Laser Happened: Adventures of a Scientist,” Charles H. Townes, Oxford University Press, (1999).
302. “Infrared Seti,” Charles H. Townes, *SPIE Proc.* **1867**, 121 (1993).
303. “Evidence for a massive black hole in the center of our galaxy,” Charles H. Townes, in *Quantum Coherence and Reality*, J.S. Anandan and J.L. Safko (eds.), *Proc. of Int’l. Conf. on Fund. Aspects of Quant. Theory*, World Scientific Publishing (1994).
304. “Characteristics of dust shells around 13 late-type stars,” W.C. Danchi, M. Bester, C.G. Degiacomi, and L.J. Greenhill, and C.H. Townes, *AJ* **107**, 4, 1469 (1994).
305. “Heterodyne interferometry in the infrared,” C.H. Townes, M. Bester, W.C. Danchi, C.G. Degiacomi, and L.J. Greenhill, *Very High Angular Resolution Imaging*, J.G. Robertson and W.J. Tango (eds.) **19**, Kluwer (1994).
306. “Long baseline interferometric observations of circumstellar dust shells at 11 microns,” W.C. Danchi, L. Greenhill, M. Bester, C.G. Degiacomi, C.H. Townes, and M.G. Wolfire, *Very High Angular Resolution Imaging*, J. G. Robertson and W.J. Tango (eds.) 383, 19 Kluwer (1994).
307. “Recent astronomical results from the infrared spatial interferometer and their implications for LOUISA,” W.C. Danchi, M. Bester, and C.H. Townes, *Proc. of a Workshop on a Lunar Optical-Ultraviolet-Infrared Synthesis Array (LOUISA)*, J.O. Burns (ed.), *NASA Conference Publication* **3066**, 75-92 (1992).
308. “Latest technical developments at the infrared spatial interferometer,” M. Bester, C.G. Degiacomi, W.C. Danchi, L.J. Greenhill, C.H. Townes, A. Reisinger, and J. Weaver, *Very High Angular Resolution Imaging*, J.G. Robertson and W.J. Tango (eds.), 257-260, Kluwer (1994).
309. “An IR spatial interferometer at 10  $\mu\text{m}$  wavelength and measurement of stellar dust shells,” C.H. Townes, M. Bester, W.C. Danchi, C.G. Degiacomi, and L.J. Greenhill, *Infrared Phys. Technol.* **35**, No. 2/3, 503 (1994).
310. “Introduction: Radio and IR studies of molecular clouds,” Charles H. Townes, *The Structure and Content of Molecular Clouds*, T.L. Wilson and K.J. Johnston (eds.), Springer-Verlag (1994).
311. “Surprise and sociology in multi-disciplinary sciences,” *Very High Angular Resolution Imaging*, J.G. Robertson and W.J. Tango (eds.) 47-59, Kluwer (1994), and also in *Current Science Assn.* M.S. Venugopal (ed.), Bangalore, India (Dec. 1993).

312. “Why are we here; where are we going?” in *The International Community of Physics, Essays on Physics*, V.A. Stefan (ed.), AIP (1997). Also “Humanity and the Cosmos,” *Im Anfang war ein Gott*, Patmos Verlag, T. B. Wabbel (ed.) 2004
313. “Making Waves,” *Masters of Modern Physics*, Robert N. Ubell (ed.) American Institute of Physics, 1995.
314. “The nucleus of our galaxy,” Reinhard Genzel, David Hollenbach, and Charles H. Townes, *Rep. Prog. Phys.* **57**, 417 (1994).
315. “Reflections on the relations between science and religion,” Charles H. Townes, Inaugural Lecture, Center for Faith and Science Exchange and Harvard Divinity School, Feb. 27, 1991.
316. “Perspectives on conditions which encourage the development of science and technology,” C.H. Townes, Pontifical Academy, 1990.
317. “Science and Technology,” Charles H. Townes, *The Physical Review - The First 100 years*, Henry Stroke (ed.), Chapter 13, 1099, AIP Press (1995).
318. “A Life in Physics: Bell Telephone Laboratories and WWII, Columbia University and the Laser, MIT and Government Service; California and Research in Astrophysics,” University of California at Berkeley Oral History of Charles H. Townes and Frances Townes, Suzanne Riess (ed.), (1993).
319. “Prospects for the physical sciences,” Charles H. Townes, *Nat. Sci. Symp. NRL* (June 14, 1993).
320. “Heterodyne spectroscopy of solar OH lines at 12 microns with a diode laser as local oscillator,” Charles H. Townes and John J. Ottusch. **In progress.**
321. “The nuclei of normal galaxies: lessons from the Galactic Center - a brief summary,” Charles H. Townes, *The Nuclei of Normal Galaxies*, R. Genzel and A.I. Harris (eds.), 463, Kluwer Academic Publishers (1994).
322. CO Observations of Molecular Clouds in the Disk of M 83 “Thin molecular clouds in M83,” N. Geis, C.H. Townes, J. Lugten and R. Genzel. **In progress.**
323. “The University in the Twenty-first Century: A Symposium to Celebrate the Centenary of the University of Chicago,” Charles H. Townes, *Minerva* Vol. XXX, No. 2, Summer 1992.
324. “Properties and evolution of the central stellar cluster,” R. Genzel, D.J. Hollenbach, C.H. Townes, A. Eckart, A. Krabbe, D. Lutz, and F. Najarro, *The Nuclei of Normal Galaxies: Lessons from the Galactic Center*, R. Genzel and A.I. Harris (eds.), 327, Kluwer Academic Publishers, 1994.
325. empty
326. “158  $\mu\text{m}$  [C II] mapping of galaxies: probing the atomic medium,” S.C. Madden, N. Geis, R. Genzel, F. Herrmann, J. Jackson, A. Poglitsch, G.J. Stacey, and C.H. Townes, *The Evolution of Galaxies and their Environment, NASA Conf. Publ.* **3190**, 185 (1993).
327. “Far-infrared line images of dwarf galaxies,” A. Poglitsch, N. Geis, R. Genzel, F. Herrmann, S.C. Madden, G.J. Stacey, and C.H. Townes, *The Evolution of Galaxies and their Environment, NASA Conf. Publ.* **3190**, 187 (1993).
328. “Analysis of visibility data from the U.C. Berkeley Infrared Spatial Interferometer—radiative transfer modeling and results on fifteen stars,” W.C. Danchi, M. Bester, L.J. Greenhill, C.G. Degiacomi, and C.H. Townes, *Amplitude and Intensity Spatial Interferometry*, J.B. Breckinridge, (ed.), *Proc. SPIE* **2200**, paper 27 (1994).
329. “Toward astrometric tracking with the Infrared Spatial Interferometer,” R.N. Treuhaft, M. Bester, W.C. Danchi, and C.H. Townes, *TDA Progress Report* **42-116**, 9 (1994).
330. “Toward 10-milliarcsecond infrared astrometry,” R.N. Treuhaft, S.T. Lowe, M. Bester, W.C. Danchi, and C.H. Townes, *Amplitude and Intensity Spatial Interferometry*, J.B. Breckinridge, (ed.), *Proc. SPIE* **2200**, 316 (1994).
331. “Spectroscopy of the galactic center arches region: evidence for massive star formation,” A.I. Harris, T. Krenz, R. Genzel, A. Krabbe, D. Lutz, A. Poglitsch, C.H. Townes, and T.R. Geballe, *The Nuclei of Normal*



- Galaxies: Lessons from the Galactic Center*, R. Genzel and A.I. Harris (eds.), **445**, p. 223, Kluwer Academic Publishers (1994).
332. "Far-infrared studies of the Orion Nebula," F. Herrmann, N. Geis, R. Genzel, S.C. Madden, A. Poglitsch, G.J. Stacey, and C.H. Townes, *Infrared Phys. Technol.* **35**, No. 2/3, 161 (1994).
333. "The interstellar medium of galaxies as seen through images of the 158  $\mu\text{m}$  [C II] line," S.C. Madden, N. Geis, R. Genzel, F. Herrmann, A. Poglitsch, G.J. Stacey, and C.H. Townes, *Infrared Phys. Technol.* **35**, No. 2/3, 311 (1994).
334. "Infrared observations of the center of the galaxy," A. Poglitsch, N. Geis, R. Genzel, A.I. Harris, J.M. Jackson, T. Krenz, S.C. Madden, G.J. Stacey, and C.H. Townes, *Infrared Phys. Technol.* **35**, No. 2/3, 419 (1994).
335. "Far infrared spectra of galaxies," Charles H. Townes and N. Geis, *Proc. of the SPIE* **2211**, p. 14 (1994).
336. "Vertical scales of turbulence at the Mount Wilson Observatory," R.N. Treuhaft, S.T. Lowe, M. Bester, and W.C. Danchi, and C.H. Townes, *ApJ* **453**, 522 (1995).
- 337.m. "Lasers," *Scientific American*, 150<sup>th</sup> Anniversary book. Robert Ubell Associates, NY. **In progress**.
338. "Is there a compact central mass concentration in our galaxy?" C.H. Townes, *Unsolved Problems of the Milky Way*, L. Blitz and P. Teuben (eds.), p. 149-168, IAU (1996).
339. "Dust shells around late type stars: what kind of science can be done with the VLT interferometer?," with B. Lopez, W.C. Danchi, M. Bester, and J. Lefèvre, *Science with the VLT: Proceedings of the European Southern Observatory Workshop*, Jeremy R. Walsh and Ivan J. Danziger (eds.), p.69 (1995)
340. "Inner radii of dust shells and stellar diameters obtained by an infrared stellar interferometer at 11 micron wavelength," W.C. Danchi, M. Bester, L.J. Greenhill, C.G. Degiacomi, N. Geis, D. Hale, B. Lopez, and C.H. Townes, *Astrophysics and Space Science* **224**, 447 (1995).
341. "FIFI - the MPE Garching/UC Berkeley Far-Infrared Imaging Fabry-Pérot Interferometer," N. Geis, R. Genzel, M. Haggerty, F. Herrmann, J. Jackson, S.C. Madden, T. Nikola, A. Poglitsch, M. Rumitz, G.J. Stacey, R. Timmermann, and C.H. Townes, *Proc. of the Airborne Astronomy Symposium on the Galactic Ecosystem*, M.R. Haas, J.A. Davidson, and E.F. Erickson (eds.), ASP **73**, 547 (1994).
342. "The Orion molecular clouds OMC-1 and OMC-2 mapped in the far-infrared fine-structure line emission of C<sup>+</sup> and O<sup>0</sup>," F. Herrmann, S.C. Madden, T. Nikola, A. Poglitsch, R. Timmermann, N. Geis, C.H. Townes, and G.J. Stacey, *ApJ* **481**, 343 (1997).
343. "Unpredictability in science and technology," Charles Hard Townes, *Science and Society*, Martin Moskowitz (ed.) The John C. Polanyi Nobel Laureates Lectures, U. of Toronto, 129, Anansi (1995).
344. "Far-infrared observations of the center of the galaxy," A. Poglitsch, N. Geis, R. Genzel, F. Herrmann, J.M. Jackson, S.C. Madden, T. Nikola, G.J. Stacey, and C.H. Townes, *The Nuclei of Normal Galaxies*, R. Genzel and A.I. Harris (eds.) 239, Kluwer (1994).
345. "A multi-wavelength study of 30 Doradus: the interstellar medium in low-metallicity galaxy," A. Poglitsch, R. Genzel, F. Herrmann, A. Krabbe, S.C. Madden, N. Geis, G.J. Stacey, C.H. Townes, and L.E.B. Johansson, in *Airborne Astronomy Symposium on the Galactic Ecosystem*, M.R. Haas, J.A. Davidson, and E.F. Erickson (eds.), ASP Conference Series **73**, 141 (1995).
346. "Extragalactic diffuse [C II] emission," S.C. Madden, N. Geis, C.H. Townes, R. Genzel, F. Herrmann, A. Poglitsch, and G.J. Stacey, in *Airborne Astronomy Symposium on the Galactic Ecosystem*, M.R. Haas, J.A. Davidson, and E.F. Erickson (eds.), ASP Conference Series **73**, 181 (1995).
347. "A search for hydrogen lasers in MWC 349 from the KAO," Vladimir S. Strel'nitski, Howard A. Smith, Michael R. Haas, Sean W.J. Colgan, Edwin F. Erickson, Norbert Geis, David J. Hollenbach, and Charles H. Townes, in *Airborne Astronomy Symposium on the Galactic Ecosystem*, M.R. Haas, J.A. Davidson, and E.F. Erickson (eds.), ASP Conference Series **73**, 271 (1995).

348. “Measurement at 11 micron wavelengths of the diameters of  $\alpha$  Orionis and  $\alpha$  Scorpii; and changes in effective temperature of  $\alpha$  Orionis and very recent dust emission,” M. Bester, W.C. Danchi, D. Hale, C.H. Townes, C.G. Degiacomi, D. Mékarnia, and T.R. Geballe, *ApJ* **463**, 336 (1996).
349. “Far-IR observations of the radio arc (thermal arches) in the Galactic Center,” R. Timmermann, R. Genzel, A. Poglitsch, D. Lutz, S. Madden, T. Nikola, N. Geis, and C.H. Townes, *ApJ* **466**, 242 (1996).
350. “Possible discovery of the  $70\ \mu\text{m}\ \text{H}_3\text{O}^+ 4^-_3 \rightarrow 3^+_3$  transition in Orion BN-IRc2,” R. Timmermann, T. Nikola, A. Poglitsch, N. Geis, G. Stacey, and C.H. Townes, *ApJ Letts.* **463**, L109 (1996).
351. “Logic and uncertainties in science and religion,” Charles H. Townes, *Science and Theology: The New Consonance*, T. Peters (ed.), Chapter 2, WestView Press (1997), **also in** *Materie, Geist Und Bewusstsein, Europaisches Forum Alpbach 1999*, **190**, and in *Science and the Future if ManKind, Preceedings of the Jubilee Plenary Session of the Pontifical Academy of Science* (2000).
352. “Early days of quantum electronics and the Office of Naval Research,” Charles H. Townes, *50th Anniversary of the Office of Naval Research, Naval Research Reviews*, Office of Naval Research, XLVIII, 1 (1996).
353. “Nonspherical structures and temporal variations in the dust shell of  $\alpha$  Ceti observed with a long baseline interferometer at 11 microns,” B. Lopez, W.C. Danchi, M. Bester, D.D.S. Hale, E.A. Lipman, J.D. Monnier, P.G. Tuthill, C.H. Townes, C.G. Degiacomi, T.R. Geballe, L.J. Greenhill, P. Cruzalebes, J. Lefevre, D. Mekarnia, J.A. Mattei, D. Nishimoto, and P.W. Kervin, *ApJ*, **488**, 807 (1997).
354. “Contribution of laser technology to astronomy with emphasis on interferometry,” C.H. Townes, *Laser Physics* **7**, No. 1, 1 (1997).
355. “Nonuniform dust outflow observed around the infrared object NML Cygni,” J.D. Monnier, M. Bester, W.C. Danchi, M.A. Johnson, E.A. Lipman, C.H. Townes, P.G. Tuthill, T.R. Geballe, D. Nishimoto, and P.W. Kervin, *ApJ* **481**, 420 (1997).
356. “Optical and infrared SETI,” Charles H. Townes, *Astronomical and Biochemical Origins and the Search for Life in the Universe, Proceedings of the 5th International Symposium on Bioastronomy, IAU Colloqu. No. 161*, C.B. Cosmovici, S. Bowyer, and D. Werthimer (eds.), Editrice Compositori, Bologna (1997), p. 585.
357. “Faith and Values in Science and Religion: A Discussion with Prof. Charles H. Townes,” The Bhaktivedanta Institute (San Francisco), 1997 transcript of video .
358. “A physicist courts astronomy,” C.H. Townes, Prefatory Chapter of *Annual Review of Astronomy and Astrophysics*,” Vol. 35 (1997).
359. “Multiple dust shells and motions around IK Tauri as seen by infrared interferometry,” David D.S. Hale, M. Bester, W.C.Danchi, S. Hoss, E. Lipman, J.D. Monnier, P.G. Tuthill, C.H. Townes, M. Johnson, B. Lopez, and T.R. Geballe, *ApJ* **490**, 407 (1997).
360. “Far-infrared fine structure line observations of the galactic center radio arc,” A. Poglitsch, R. Genzel, S. Madden, T. Nikola, R. Timmermann, N. Geis, and C.H. Townes, in *The Galactic Center*, R. Gredel (ed.), *ASP Conf. Series* **102**, 114 (1996).
361. “Science, Technology, and Education in the 21<sup>st</sup> Century”, Forum: Creativity towards the 21<sup>st</sup> Century, Japan (1999)
362. “What’s going on in the center of our galaxy?” Rajiv Gandhi Lecture, New Delhi, 1997.
363. “Astronomical masers and lasers,” C.H. Townes, *Quantum Electronics*, 27, 1031, Arkady Z. Grasiuk (ed.), Moscow, SU. (1997).
364. “[C II] 158 micron observations of IC 10: evidence for hidden molecular hydrogen in irregular galaxies,” S.C. Madden, A. Poglitsch, N. Geis, G.J. Stacey, and C.H. Townes, *ApJ* **483**, 200 (1997).

365. “Do science and religion converge?” C.H. Townes, *Second World Congress for the Synthesis of Science and Religion, Calcutta 1997*. The Bhaktivedanta Institute (San Francisco) 1997. Published in *Thoughts on Synthesis of Science and Religion*, 2001
366. “Atmospheric pathlength fluctuations in the infrared spatial interferometer,” M. Bester, W.C. Danchi, C.G. Degiacomi, L.J. Greenhill, and C.H. Townes, *Adaptive Optics for Large Telescopes, Technical Digest*, Optical Society of America **19**, 48 (1992).
367. “Spatial interferometry in the mid-infrared,” C.H. Townes, *Adaptive Optics for Large Telescopes, Technical Digest*, Optical Society of America **19**, 198 (1992).
368. “Mid-infrared spatial interferometry on late-type stars and their circumstellar material,” C.Townes, W. Danchi, M. Bester, P. Tuthill, J. Monnier, E. Lipman, and D. Hale, *A Half Century of Stellar Pulsation Interpretations: A tribute to Arthur N. Cox*, ed., P.A. Bradley and J.A. Guzik, APS Conference Series 135, 316 (1998).
369. “Secular variations and non-spherical structures in the dust shell of o-Ceti observed with a long-baseline interferometer at 11  $\mu\text{m}$ ,” W.C. Danchi, P.G. Tuthill, M. Bester, E.A. Lipman, J.J. Monnier, and C.H. Townes, in *A Half Century of Stellar Pulsation Interpretations: A tribute to Arthur N. Cox*, ed., P.A. Bradley and J.A. Guzik, APS Conference Series 135, 327 (1998).
370. “Observations and modeling of the nonuniform dust outflow around the red supergiant NML-Cygni,” J. Monnier, M. Bester, W.C. Danchi, M.A. Johnson, E.A. Lipman, C.H. Townes, P.G. Tuthill, and T.R. Geballe, in *A Half Century of Stellar Pulsation Interpretations: A tribute to Arthur N. Cox*, ed., P.A. Bradley and J.A. Guzik, APS Conference Series 135, 329 (1998).
371. “Science and Technology”, *The Physical Review, The First Hundred Years*, pg. 1099, ed. H.H. Strocke, AIP Press (1995).
372. “IR imaging of circumstellar environments,” C.H. Townes, W.C. Danchi, P.G. Tuthill, M. Bester, E.A. Lipman, J.M. Monnier, *Cool Star 10, ASP Conference Proceedings*, eds. Bob Donahue and Jay Bookbinder (1998).
373. “Infrared Spatial Interferometer,” C.H. Townes, M. Bester, W.C. Danchi, D.D.S. Hale, J.D. Monnier, E.A.Lipman, P.G. Tuthill, M.A. Johnson, and D. Walters, *Astronomical Interferometry*, Robert D. Reasenberg, (ed.), *SPIE Proceedings* **3350**, 908 (1998).
374. “Near-infrared guiding and tip-tilt correction for the UC Berkeley Infrared Spatial Interferometer,” E.A Lipman, M. Bester, W.C. Danchi, C.H. Townes, *Astronomical Interferometry*, Robert D. Reasenberg, (ed.), *SPIE Proceedings* **3350**, 933 (1998).
375. “Lasers Physics: Quantum Controversy in Action,” W.E. Lamb, W.P. Schleich, M.O. Scully and C.H.Townes, *More Things in Heaven and Earth: A Celebration of Physics at the Millenium*, Benjamin Bederson (ed.) pg. 442 (1999).
376. “[CII] Emission from NGC 4038/39 (The “Antennae”),” Thomas Nikola, Reinhard Genzel, Franz Hermann, Suzanne C. Madden, Albrecht Poglitsch, Norbert Geis, Charles H. Townes, Gordon J. Stacey, *Max-Planck-Institute für Extraterrestrische Physik, Ap.J.*, **504**, 749 (1998).
377. “La Convergence entre la Science el la Religion’ C. H. Townes, pg 8 of Science and Religion, numero special, Printemps 2000, Universite Interdisciplinaire de Paris
378. “Arthur Schawlow (1921-1999): Laser Scientist,” Charles H. Townes, *Nature* Vol. 399, June (1999).
379. “Starformation in M51 Triggered by the Galaxy Interaction,” T. Nikola, N. Geis, R. Genzel, F. Herrmann, S. C. Madden, A. Poglitsch, G. J. Stacey, C. H. Townes *Ap.J.*, **561**, 1 (2001).
380. “Resistance to Change and New Ideas in Physics: a Personal Perspective,” Charles H. Townes, Talk at Gunther Stent Symposium, “Prematurity in Scientific Discovery”, December 1997. edited by E. B. Hook Ch.: 4, p. 46-58, 2002, University of California Press (also 413)

381. “Conference Summary: The Central Parsecs,” C. H. Townes, , A. S. P. Conference Series, The Central Parsecs of the Galaxy, ed. H. Falcke et al, Sheridan Books, Inc., Vol. 186 pp. 611-616 (1999).
382. “Laser Pioneer Arthur Schawlow Passes Away: Charles Townes remembers his friend and colleague,” C. H. Townes, Optics and Photonics News, Vol. 10, No. 6, June (1999).
383. “The U. C. Berkeley Infrared Spatial Interferometer: A Heterodyne Stellar Interferometer for the Mid-Infrared,” D. D. S. Hale, M. Bester, W. C. Danchi, W. Fitelson, S. Hoss, E. A. Lipman J. D. Monnier, P. G. Tuthill, and C. H. Townes. *ApJ* 537, 998 (2000).
384. “Interferometric Observations of IRC+10011 and IRC+10420 in the Mid-Infrared,” E. A. Lipman, D. D. S. Hale, J. D. Monnier, C. H. Townes. *ApJ.*, 532, 467 (2000).
385. “Parallel paths”, Charles H. Townes, written in honor of Walter Knight, Philosophical Magazine B, Vol. 79, No. 9, (1245-46), 1999.
386. “Quantum effects and optimization of heterodyne detection”, M.A. Johnson, C.H. Townes, written in honor of Marlan Scully. Published by Elseuier 2000, ed W. Schleich, H. Talther, W.E. Lamb, Johnson and Townes, Pg 183-187, also Optics Communications, Vol 179.
387. “Advances in Semiconductor Lasers and Application to Optoelectronics”, Prefatory remarks written by CH Townes, Editors, M. Dutta and M.A. Stroschio. Published by World Scientific PubCo, Nov. 2000, Chapter 4, p.59-66
388. “Noise and Sensitivity in Interferometry”, C. H. Townes, published talk given at Michelson Interferometry Summer School, California Institute of Technology, JPL, Aug. 9-13, 1999.*Principles of Long Baseline Interferometry, Course Notes from Michelson Interferometry Summer School.*publ.8/2000, 338p., Editor: Peter Lawson
389. “Michelson & Pease’s Interferometric Stellar diameters”, C. H. Townes, The Astrophysical Journal, Centennial Issue: 1-1284, Vol. 525, No. 1C, Part 3, 1999.
390. “Mid-infrared Interferometry on Spectral Lines: I. Instrumentation”, J.D. Monnier, W. Fitelson, W.C. Danchi and C. H. Townes. *ApJ. Suppl. Series* , **129**, 421 (2000).
391. “Mid-infrared Interferometry on Spectral Lines: II. Continuum (dust) emission around IRC +10216 and VY CMa”, J. D. Monnier, W. C. Danchi, D. S. Hale, E. A. Lipman, P. G. Tuthill, and C. H. Townes. *ApJ.* **543**, 861, (2000)
392. “Mid-infrared Interferometry on Spectral Lines: III. Ammonia and Silane around IRC +10216 and VY CMa”, J. D. Monnier, W. C. Danchi, D. S. Hale, P. G. Tuthill and C. H. Townes. *Ap.J.*,**543**, 868 (2000).
393. “Charles H. Townes: How can we be wiser about decisions of what to pursue in science and technology?” Janie Fouke, Editor, Trudy E. Bell and Dave Dooling, Writers, Engineering Tomorrow—Today’s Technology Experts Envision the Next Century, Ch. 1: Threshold of the New Millennium, pp. 24-29 (2000).
394. “Near and mid-IR subarcsecond structure of the dusty symbiotic star R-Aquar”, P.G. Tuthill, W.C. Danchi, D.S. Hale, J.D. Monnier, and C.H. Townes. *ApJ* 534, 907 (2000)
395. “Precision Measurements of the Diameters of  $\alpha$  Orionis and o Ceti at 11 Microns”, J. Weiner, W.C. Danchi, D.D.S. Hale, J. McMahon, C.H. Townes, J.D. Monnier, and P.G. Tuthill. *ApJ* **544**, 1097-1100 (2000)
396. “Noise and Sensitivity in Interferometry”, C.H. Townes, page 59, *Principles of Long Baseline Interferometry*, ed. Peter Lawson (1999).
397. “Proper Motions of Dust Shells Surrounding NML Cygni”, W. C. Danchi, W. H. Green, D. D. S. Hale, K. McElroy, J. D. Monnier, P. G. Tuthill, and C. H. Townes, *ApJ* , Vol 555, 405, (2001)
398. “Introduction to the Millennium Issue of the Journal of Selected Topics in Quantum Electronics”, C. H. Townes, *IEEE Journal on Selected Topics in Quantum Electronics*, Vol. 6. No. 6. Nov/Dec (2000)

399. “The Light That Shines Straight” C. H. Townes (edited by Michael Riordan) *Beam Line*, Summer-Fall (2000)
400. William Aaron Nierenberg Obituary, C. Townes and W. Munk, *Physics Today*, June 2001
401. “The Potential for Atmospheric Path Length Compensation in Stellar Interferometry”, *ApJ* **565**, 1376 (2002)
402. “Mid-Infrared Stellar Interferometry and Diameters of Old Stars, *American Institute of Physics* (2001), D. Budker, et al, ed.
403. “Testing Faith, Wrestling with Mystery”, An interview published in *Faith in Science*, by W. M. Richardson and G. Start, Publisher: Routledge, London and New York (2001)
404. Original transcript of the presentation by Charles H. Townes – 10<sup>th</sup> International Zermatt Symposium/ Friday 13 January 2000
405. “Stellar Interferometry at Mid-Infrared Wavelengths”, Lomonosov Award Ceremony presentation, Russian Academy of Sciences – November 11-15, 2001
406. “The Convergence of Science and Religion” Speech at UNESCO, Paris, April 17, 2002, “Science and the Search for Meaning”, Templeton Foundation Press, Editor Jean Staune (Same title as #139 but different).
407. “Sociology and Unpredictability in the Growth of Science and Technology” Deliver on the Occasion of the Acceptance of the Rabindranath Tagore Plaque of the Asiatic Society, November 5, 1999 –published by The Asiatic Society, edited by J. Dutta, Published 2002
408. “The Berkeley Infrared spatial Interferometer: A Heterodyne Stellar Interferometer For The Mid-Infrared”, D. Hale, M. Bester, W. Danchi, W. Fitelson, S. Hoss, E. A. Lipman, J. D. Monnier, P. G. Tuthill, and C.H. Townes, *ApJ* **537**: 998-1012, 2000
409. “Reflections on Forty Years of Optical SETI – Looking Forward and Looking Backward”, C.H.Townes, January 20-26, 2001: OSETI III Conference, Photonics West, Convention Center, San Jose
410. “Low Altitude Atmospheric Turbulence Characteristics at Mt. Wilson Observatory” N. Short, W. Fitelson, D. Hale, and C. H. Townes, Proceedings of SPIE, V488, 803 (2003)
411. “Imaging The Disk Around The Luminous Young Star LkH $\alpha$  101 With Infrared Interferometry”, P. Tuthill, J. Monnier, W. Danchi, D. Hale, C. H. Townes, *ApJ*, **577**: 826-838, 2002 October 01
412. “Faith and the Pursuit of Understanding in Science and Religion”, page 306 in “Science and Beyond” published by National Institute of Advance Studies, Bangalore, India (2003) ed. S. Menon, B. V. Sreekantan, A. Sinha, P. Clayton, and R. Narasimha.
413. “Techniques for Measuring Phase Closure at 11 Microns”, D. Hale, W. Fitelson, J. Monnier, J. Weiner, C.H. Townes, “Interferometry for Optical Astronomy II”, Conferences, August 22-28, 2002, Waikolea, Hawaii, Proceedings of SPIE, Vol 4383, 387-397, 2003
414. “The Variability of Late-Type Stars Diameters Measured Using Mid-Infrared Interferometry”, J. Weiner, D. Hale, C. H. Townes, “Interferometry for Optical Astronomy II”, Conferences, August 22-28, 2002, Waikolea, Hawaii, Proceedings of SPIE, Vol 4838. 172-180, 2003
415. “Harnessing Light”, C. H. Townes in “Past to Present: Ideas that changed our World”, edited by S. Hirschberg and T. Hirschberg, Ch.: 5, p. 475, May 2002, Prentice Hall (also 230)
416. (a) “Arthur Schawlow”, S. Chu and C.H. Townes, , National Academy of Sciences Biographical Memoirs, V.83, 2003  
(b) ) “Arthur Schawlow”, S. Chu and C.H. Townes, Am. Phil. Soc., 2004
417. “Interferometry on Mira in the Mid-Infrared, Cyclic Variability of the continuum Diameter and the effect of spectral Lines on Apparent size”, J. Weiner, D. D. S. Hale, C. H. Townes, *ApJ*. V.588, 1064 (2003)

418. “The Laser- What it is and how it happened”, C.H. Townes, C.N. Yangs 80’ birthday celebration speech, 2002, International Journal of Modern Physics B, 16, 4655 (2002)
419. “Laser and Fiber Optics”, in: “Greatest Achievements in Engineering”, edited by R. Conlan, received 2002, 256 pages, 2003
420. “Logic and Uncertainties in Science and Religion”, C.H. Townes, Chapter 2 from Science and Theology: The new Consonance (Westview Press, 1997), edited by Ted Peters, to be republished by Kang Phee Seng, 2002
421. “The Behavior Of Stars Observed By Infrared Interferometry”, Talk presented for the Karl-Schwartzschild-Award, Berlin, Germany, Sept. 2002, Astronomische Gesellschaft Reviews in Modern Astronomy 16, 1 (2003). Also in “The Cosmic Circuit of Matter”, Review in Modern Astronomy, ed. R. Scheilicke, 16, 1 (2003)
422. “The Convergence of Science and Religion”, C.H. Townes, ASA Journal: Perspectives on Science and Christian Faith, V55, 154 (2003)
423. “The First Laser”, C.H. Townes, in *Nature ‘Top 20’* (in Japanese) Nature Publishing Group, Century of Nature”, University of Chicago Press, 2003. Japanese edition published 2002
424. The Creative and Unpredictable Interaction of Science and Technology, the Birla Lecture, Charles Townes, January, 2003
425. “Asymptotic Giant Branch and Supergiant Stellar Diameters in the Mid-Infrared”, J. Weiner, D. D. S. Hale, and C. H. Townes, *ApJ*, Vol. 589, 976 (2003)
426. “Atmospheric Turbulence Measurements at Mt. Wilson Observatory”, N. Short, W. Fitelson, C. H. Townes, *ApJ*, Vol 599, 58339 (2003)
427. “Mid-Infrared Interferometry on Dust Shells around 4 Late Type Stars”, S. Tevousjan, J. Weiner, K. S. Abdeli, D. D. S. Hale, C. H. Townes, *ApJ*, **Vol 611, 466 (2004)**
428. “High-resolution Imaging of Dust Shells Using Keck Aperture Masking and the IOTA Interferometer, J. D. Monnier, R. Millan-Gabet, P. G. Tuthill, W. A. Traub, N. P. Carleton, V. Coudé du Foresto, W. C. Danchi, M. G. Laeasse, S. Morel, G. Perrin, I. L. Porro, and C. H. Townes, *ApJ* 605, 436 (2004).
429. “Basic Puzzles in Science and Religion.” C. H. Townes, pg. 129 in God’s Action in Nature’s World, ed T. Peters and N. Hallanger, published by Ashgate (2006)
430. “ISI: Recent Technology and Science” D. D. S. Hale, J. Weiner, C. H. Townes, Proceedings SPIE 5491, 490 (2004)
431. “Arthur Schawlow,” S. Chu and C. H. Townes, Am. Phil. Society, (2004), and Biographical Memoirs of the Nat. Acad. of Sciences, Nat. Acad. Press, 2003
432. “Science and Spiritual Exploration,” A dialogue between Charles H. Townes and T. D. Singh, Savijnanam, Journal of the Bhaktivedanta Institute, 2, 1, (2003)
433. “Dialogue on Science, Values, and Beyond” between Charles H. Townes and T. D. Singh, Seven Nobel Laureates on Science and Spirituality, ed. T. D. Singh, Bhaktivedanta Institute (2004)
434. Early History of Quantum Electronics, C. H. Townes, Journal of Modern Optics, 52, 1367 (2005)
435. “Making Waves”, C. H. Townes, *Nature*, 432, 153 (2004)
436. “First Surface-resolved Results with the IOTA Imaging Interferometer: Detection of Asymmetries in AGB stars”, Ragland, S., Traub, W.A. Schloerb, F. P., Carleton, N. P., Lacasse, M. G., Millan-Gabet, R., Monnier, J. D., Pedretti, E., Cotton W. D., Danchi, W. C., Townes, C. H., Willson, L.A., Brewer, M., Haguenaer, P., Kern, P., Labeye, P., Malbet, F., Malin, D., Pearlman, M., Perraut, K., Souccar, K., Wallace, G, *ApJ* 652, 650 (2006)
437. “Birth of the Maser and Laser”, Speech given at 40<sup>th</sup> Anniversary Celebration, Erice, Italy. 2005, Optical Chemical Sensors, pg.1, F. Baldini et al (eds.), Springer (2006)

- 437a. “My Columbia” – article in book “My Columbia”, assembled by Ashbol Green and published by Columbia University in 2005. CHT wrote a chapter pages 279-297.
438. Transcript from Templeton Prize Luncheon speech, Published in “A Chronicle” by the Canyon Institute for Advance Studies, London, England, May 3, 2005
439. “The Asymmetric Dust Environment of IK Tau”, J. Weiner, K. Tatebe, D. D. S. Hale, C. H. Townes, J. Monnier, M. Ireland, P. Tuthill, R. Cohen, R. K. Barry, J. Rajagopal, W. C. Danchi, *ApJ*. 636-1067 (2006)
440. “Science and Religion”, *Science and Spirit*, pp. 36-43, Jan.-Feb. (2006)
441. “Logic and Mystery in Science”, Science Center of Harvard University, **not officially published**
442. “Low Frequency Behavior of Turbulent Fluctuations at Mt. Wilson Observatory”, A. Wheelon, N. Short, and C. Townes, *ApJ*. 172, 720 (2007)
443. “Changes in Apparent Size of Giant Stars with Wavelength Due to Electron-Hydrogen Collisions”, K. Tatebe and C. H. Townes, *ApJ ApJ* 644, 1145 (2006)
444. “Characterisation of Dust Shell Dynamics and Asymmetry for 6 Mira-Type Stars, K. Tatebe, A.A. Chandler, D.D.S. Hale, and C.H. Townes, *ApJ*. 652, 666 (2006)
- 444(a) “Sparse-Aperture Adaptive Optics”, P. Tuthill, J. Lloyd, M. Ireland, F. Martinache, J. Monnier, H. Woodruff, T. ten Brummelaar, N. Turner, C.H. Townes, *SPIE Vol. 6272, 62723A*, (2006)
445. “The Radiative Pattern and Asymmetry of IRC+10216 at 11 Microns with Interferometry and Closure Phase, A.A. Chandler, K. Tatebe, D.D.S. Hale, and C.H. Townes, *ApJ*.657, 1042 (2007)
446. “Adaptive Optics and Aperture-masking: A Comparison”, with J. Rajagopal, R. Barry, B. Lopez, W.C. Danchi, J.D. Monnier, and P.G. Tuthill, *SPIE Vol. 491*, pg. 1120 on “New Frontiers in Stellar Interferometry” (2004)
447. “Observation of a Burst of High-Velocity Dust from  $\alpha$  - Herculis”, K. Tatebe, D.D.S. Hale, E.H. Wishnow, and C.H. Townes, *ApJ. Letters* 658, L103 (2007)
448. “The Discovery of Interstellar Water Vapor and Ammonia at the Hat Creek Radio Observatory.” C.H. Townes, in *Revealing the Molecular Universe: One Antenna is Never Enough*, eds. D.C. Baker, J.L. Turner, and J.M. Morgan, *ASP Conference Series Vol 356*, pg. 81 (2006)
449. “The Discovery of Interstellar Water Vapor and Ammonia at the Hat Creek Radio Observatory” C.H. Townes, page 81 of *Revealing the Molecular Universe: One Antenna is Never Enough*, ed. D.C. Baker, J.L. Turner, and J.M. Morgan, *Society of the Pacific Conference Services v. 356* (Taken from #301)
450. “Interferometry on Stars at Mid-Infrared Wavelengths”. K. Tatebe, D.D.S. Hale, and C.H. Townes, *SPIE Proceedings, Vol. 6678, 6678 1G* (2007)
451. “Theodore H. Maiman (1927-2007)”, C.H. Townes, *Nature* 447, 654 (2007)
452. “Asymmetries and Outflows in the Circumstellar Dust of Mira A”, A.A. Chandler, K. Tatebe, E.H. Wishnow, D.D.S. Hale, and C.H. Townes, *ApJ*. 670 (2007)
453. “Adventures of a Scientist: Conversation with Charles H. Townes, Institute of International Studies, U.C. Berkeley (2007). To be published perhaps, now just on line
454. “Can We Understand Free Will?”, C.H. Townes, page 636, *Visions of Discovery*, Columbia University Press (2011)
455. “The Laser”, C.H. Townes, to be published in *Scholarpedia* (not published)
456. “The Nonspherical Shape of Betelgeuse in the Mid-Infrared”, K. Tatebe, A.A. Chandler, E.H. Wishnow, D.D.S. Hale, C.H. Townes, *ApJ*. 670, L21 (2007)
457. “Interferometry at Mid-Infrared Wavelengths: The ISI System”, C.H. Townes and E.H. Wishnow, *Proceedings of the SPIE* 7013, 70130D (2008)

458. "How the Laser Started", *Journal of Laser Applications* 21, 205 (2009)
459. "The Evolving Shapes of O Ceti and R Leonis, K. Tatebe, E.H. Wishnow, C.S. Ryan, D.D.S. Hale, and C.H. Townes, *Ap.J.* 689, 1289 (2008)
460. "The Keck Aperture Masking Equipment: Spectra-Interferometry of 3 Mira Variables from 1.2 to 3.8  $\mu$  m, H.C. Woodruff, M.J. Ireland, P.G. Tuthill, J.D. Monnier, T.R. Bedding, W.C. Danchi, M. Scholz, C.H. Townes and P.R. Wood, *Ap.J.* 691, 1328 (2009)
461. "The Next Fifty Years", Lecture given at Clemson University in 1963 (Not published, but lengthy and systematically written)
462. Vacant
463. "The Dust surrounding WHya", E.H. Wishnow, C.H. Townes, B. Walp, and S. Lockwood, *Ap.J.* 712, L135 (2010)
464. "A Systematic Change with Time in the Size of Betelgeuse" C.H. Townes, E.H. Wishnow, and B. Walp, *Ap.J. Letters*, 697, L127 (2009)
465. "Mira's Apparent Size Variations Due to a Surrounding Semiopaque H<sub>2</sub>O Layer," J. Weiner, *ApJ*, 661, L37 (2004)
466. "The Impact of Lasers
467. "Laser Physics: Quantum Controversy in Action", W.E. Lamb, W.P. Schleich, M.O. Scully, and C.H. Townes, page 442 in "More Things in Heaven and Earth", "A Celebration of Physics at the Millennium", ed. B. Bederson, APS 1999
468. Forward in "Visions of Discovery, in honor of C.H. Townes' 90<sup>th</sup> birthday", Ed. R. Chiao, Cambridge Press, 2011.
469. Preface to book entitled "Le Laser", published 2010 EDP Sciences; also, a French edition in *Reflète Physique* 21, 10 (2010)
470. "Development of the Physics of Microwaves and its Unification with Infrared and Optical Science", C.H. Townes, *Journal of the European Optical Society; Rapid publications*, Vol. 5, 10043 (2010)
471. "Science et Religion Doivent Converger", pg. 36 *Le Monde*, Jan-Feb 2010 (also 488
472. "The Dust Immediately Surrounding VHya", C. Townes, E. Wishnow, and V. Ravi, *Astronomical Society of the Pacific*, **123**:1370-1373, (2011) Same as #488
473. *Scienza: l'esperienza umana della scoperta* (comments on invention and discovery), *Le Conoscenza e Sempre un Arvenimento. Report of Remini meeting, Mondadori Univ.*, pg. 181, 186, 192, (2009)
474. "The Laser, and the Problems of New Discoveries", (Lecture in San Marino) (2009)
475. "Mid-Infrared Interferometry with High Spectral Resolution," E.H. Wishnow, W. Mallard, V. Ravi, S. Lockwood, W. Fitelson, D. Werthimer, C.H. Townes, *Proc. SPIE Vol. 7734*, 773409, Eds. W.C. Danchi, F. Delplancke, J. Rajagopal, (2010)
476. Duplicate of 462
477. Duplicate of 458
478. Duplicate of 456
479. "The Laser and the course of its discovery", Editorial for *Laser and Photonics Review*, Guido Fuchs, Editor, September 2010



480. Interview with Charles Townes for Laser Community Magazine, August 2010
481. Interview with Charles Townes by Nora Monroe for the American Philosophical Society Archives, April 23, 2010, Philadelphia, telephone no. (215)440-3450. Not yet published
482. “The Laser and How it Happened”, talk at meeting of Pontifical Academy of Sciences, Rome, October 2010
483. “The Laser, and Honor to Gerhard Herzberg, C.H. Townes, Physics in Canada, 66, no. 4 (2010)
484. “The Laser – It’s Discovery, Development, and Future” - for 50<sup>th</sup> anniversary of the laser, Moscow
485. “The Many Faces of Betelgeuse”, V. Ravi, E. Wishnow, S. Lockwood, and C.H. Townes; Cool Stars meeting 16th Cambridge Workshop on Cool Stars, Stellar Systems, and the Sun, Eds. C.K. Johns-Krull, M.K. Browning, A.A. West, ASP Conference Series Vol. 448 pg. 207 (2011)
486. “Observations of late-type stars with the Infrared Spatial Interferometer”, E. Wishnow, C. H Townes, V. Ravi, S. Lockwood, H. Mistry, W. Fitelson, W. Mallard, D. Werthimer, ASP Conference; to be published Dec. 2010.
487. “How New Things Happen”, in book published by Lenox Laser on The First Light Seminar, Oct. 2010.
488. “The Non-uniform Dynamic Atmosphere of Betelgeuse Observed at Mid-Infrared Wavelengths”, V. Ravi, E. Wishnow, C. Townes, S. Lockwood, H. Mistry, and K. Tatebe, Ap.J 740, 24 (2011)
489. “The Dust Distribution Immediately Surrounding V Hydrae”, C.H. Townes, E.H. Wishnow, V. Ravi, Astronomical Society of the Pacific **123**:1370-1373, (2011) (same as #471)
490. “Recent Observations of Betelgeuse and New Instrumentation at the ISI”, S. Lockwood, E.H. Wishnow, V. Ravi, W. Fitelson, W. Mallard, D. Werthimer, H. Mistry, and C.H. Townes, ASP Conference, Series, Volume?
491. “Ground-based Optical/Infrared Interferometry: High Resolution, High Precision Imaging,” J.T. Armstrong, D. Mozurkewich, M.C. Creech-Eakman, R.L. Akeson, D.F. Buscher, S. Ragland, S.T. Ridgeway, T. ten Brummelaar, C.H. Townes, E. Wishnow, J.P. Aufdenberg, J.P. Aufdenberg, E.K. Baines, E.J. Bakker, P. Hinz, C.A. Hummel, A.M. Jorgensen, D.T. Leisawitz, M.W. Muterspaugh, H.R. Schmitt, S.R. Restaino, C. Tycner, J. Yoon, Astor2010: The astronomy and Astrophysics Decadal Survey, Technology Development Papers, no. 27 (2009)
492. “Operational Funding for Optical and Infrared Interferometers,” Creech-Eakman, Michelle; Akeson, R.; Ridgway, S.; Leisawitz, D.; Wizinowich, P.; Armstrong, J.; Haniff, C.; Hinz, P.; Hutter, D.; McAlister, H.; Ragland, S.; ten Brummelaar, T.; Townes, C.; Wishnow, E., Astro2010: The Astronomy and Astrophysics Decadal Survey, Position Papers, no. 8 (2009)
493. “Training of Instrumentalists and Development of New Technologies on SOFI=” Erikson, Edwin F.; Allamandola, Louis J.; Baluteau, Jean-Paul; Becklin, Eric E.; Bjoraker, Gordon; Burton, Michael; Caroff, Lawrence J.; Ceccarelli, Cecilia; Churchwell, Edward B; Clemens, Dan P.; Cohen, Martin; Cruikshank, Dale P.; Dinerstein, Harriet L.; Dunham, Edward W.; Fazio, Giovanni G.; Gatley, Ian; Genzel, Reinhard; Dinerstein, Harriet L.; Dunham, Edward W.; Greenhouse, Matthew A.; Harper, Doyal A.; Harvey, Paul M.; Harwit, Martin; Hildebrand, Roger H.; Hollenback, David J.; Lane, Adair P.; Larson, Harold P.; Lord, Steven D.; Madden, Suzanne; Melnick, Gary J.; Neufeld, David A.; Olkin, Catherine B.; Packham, Christopher C.; Roellig, Thomas L.; Poeser, Hans-Peter; Sandford, Scott A.; Sellgren, Kristen; Simpson, Janet P.; Storey, John W.V.; Telesco, Charles M.; Tielens, Alexander G.G.M.; Tokunaga, Alan T.; Townes, Charles H.; Walker, Christopher K.; Werner, Michael W.; Whitcomb, Stanley E.; Wolf, Juergen; Woodward, Charles E.; Young, Erick T. Zmuidzinas, Jonas, Astro2010: The Astronomy and Astrophysics Decadal Survey, Position Papers, no. 13 (2009)

494. "MOISAIC: Milliarsecond Optical/Infrared Science: Access to Interferometry for the Community", R. Akeson, J. T. Armstrong, T. ten Brummelaar, C. Haniff, D. Hutter, H. McAlister, S. Ragland, S. Ridgway, C. Townes, E. Wishnow
495. "Optics and Photonics: A Key enabling Technology: A.E. Willner, R.L. Byer, C.J. Chang-Hasnain, S.R. Forrest, H. Kressel, H. Kogelnik, G.J. Tearney, C. Townes, and M.N. Zervas, for IEEE Special Centennial Issue to be published May 2012.
496. "Interview with Charles Townes" for Issue 1, Specimen Magazine. Conducted July 21, 2011. Published online [www.specimenmagazine.org](http://www.specimenmagazine.org).
497. "Faith and the Pursuit of Understanding in Science and Religion:", Charles Townes, Public Lecture delivered at the National Institute of Advanced Studies, January 10, 2003