Charles Hard Townes

Greenville, SC, USA, 28 July 1915 - Oakland, California, USA, 27 January 2015

Nomination 26 January 1983

Field Physics

Title Professor, Nobel laureate in Physics, 1964

Most important awards, prizes and academies

Awards: Nobel Prize in Physics (1964); Comstock Prize; John J. Carty Medal of the National Academy of Sciences; Rumford Premium of the American Academy of Arts and Sciences; Thomas Young Medal and Prize of the British Physical Society; Medal of Honor of the Institute of Electrical and Electronic Engineers; Mees Medal and Ives Medal of the Optical Society of America; Niels Bohr International Gold Medal; Plyler Prize of the American Physical Society; 2000 Founders' Award of the Nat. Academy of Engineering; Lomonosov Prize of the Russian Academy of Sciences (2001); William Exner Award of Austria; Rabindranath Tagore Birth Centenary; Plaque of the Asiatic Society; Karl Schwarzschild Medal of the Astronomische Gesellschaft; Telluride Tech Festival Award of Technology (2003); Templeton Prize for 'Progress Toward Research or Discoveries about Spiritual Realities' (2005); LeConte Medallion; Along with associate Raj Reddy, Prof. Townes was awarded the Vannevar Bush Award for Lifetime Contributions and Statesmanship to Science (2006). *Academies*: National Inventors' Hall of Fame of the USA; National Academy of Sciences; Institute for Electrical and Electronic Engineers, American Physical Society; Pontifical Academy of Sciences; Royal Society of London; American Philosophical Society; American Academy of Arts and Sciences; Optical Society of America; Indian National Science Academy; Russian Academy of Sciences.

Summary of scientific research

Townes' principal scientific work has been in microwave spectroscopy, molecular and nuclear structure, quantum electronics, radio astronomy, and infrared astronomy. He was one of the initiators of high resolution microwave spectroscopy and its use in detailed examination of molecular structure and nuclear moments. He and B.P. Dailey developed an explanation of molecular hyperfine effects which allows evaluation of molecular bonding structures and of nuclear quadrupole moments. This in turn led to a systematic study of nuclear quadrupole moments and their dependence on nuclear structure. Townes initiated the field of quantum electronics, building the first maser at Columbia University. He has the fundamental patent on masers and, with A.L. Schawlow, the basic patent on lasers. This led to work on precise time and distance measurements. His subsequent work in this field included various aspects of non-linear optics, Raman scattering and self-trapping, and the use of lasers for scientific experimentation. Townes' work in radio astronomy was begun in the mid 40s with a theory of free-free emission, included the first application of maser amplifiers to radio astronomy in the 1950s, and the first discovery of complex molecules in interstellar space in the late 1960s. During the following decade, he continued active work on molecular astronomy and the interstellar medium. Since the late 1970s Townes has been occupied primarily with infrared astronomy. Much of this work has involved the invention and construction of sensitive infrared instruments both for very high spectral resolution and for high angular resolution. He has done extensive work on the interstellar medium, dense molecular clouds, and the galactic center. He is presently engaged in observing stars with a mid-infrared spatial interferometer. This instrument has located the formation of dust around stars, discovered that episodic emission of material by stars is common, provided accurate measurements of sizes of older stars, and measured the periodic expansion and contraction of Mira-type stars.

Main publications

Townes, C.H., The Ammonia Spectrum and Line Shapes Near 1.25 cm Wave-Length, *Phys. Rev.*, 70, p. 665 (1946); Townes, C.H., Interpretation of Radio Radiation from the Milky Way, *Astrophys. J.*, 105, p. 235 (1946); Townes, C.H. *et al*., Determination of Electronic Structure of Molecules from Nuclear Quadrupole Effects, *J. Chem. Phys.*, 17, p. 782 (1949); Townes, C.H. *et al*., Nuclear Quadrupole Moments and Nuclear Shell Structure, *Phys. Rev*., 76, p. 1415 (1949); Townes, C.H. *et al*., The Effects of Electronic Paramagnetism on Nucler Magnetic Resonance Frequencies in Metals, *Phys. Rev*., 77, p. 852 (1950); Townes, C.H. *et al*., The Maser: New Type of Microwave Amplifier, Frequency Standard, and Spectrometer, *Phys. Rev*., 99, p. 1264 (1955); Townes, C.H., *Microwave Spectroscopy*, McGraw-Hill (New York, 1955); Townes, C.H. *et al*., Fluctuations in Amplification of Quanta with Application to Amplifiers, *J. Phys. Soc. Japan*, 12, p. 686 (1957); also p. 517 Collection of Papers Dedicated to Masao Kotani (Tokyo, 1967); Townes, C.H. *et al*., Infrared and Optical Masers, *Phys. Rev*., 112, p. 1940 (1958); Townes, C.H. *et al*., Limits on Electromagnetic Amplification Due to Complementarity, p. 233, *Quantum Electronics* (C.H. Townes, ed.), Columbia Univ. Press (1960); Townes, C.H. *et al*., Coherently Driven Molecular Vibrations and Light Modulation, *Phys. Rev. Letters*, 11, p. 160 (1963); Townes, C.H. *et al*., Simulated Brillouin Scattering and Coherent Generation of Intense Waves, *Phys. Rev. Letters*, 12, p. 592 (1964); Townes, C.H. *et al*., Detection of NH3 Molecules in the Interstellar Medium by Their Microwave Emission, *Phys. Rev. Letters*, 21, p. 1701 (1968); Townes, C.H. *et al*., Detection of Water in Interstellar Regions by Its Microwave Radiation, *Nature*, 221, p. 626 (1969); Townes, C.H. *et al*., Observations of the Motion and Distribution of the Ionized Gas in the Central Parsec of the Galaxy, *Ap. J. Lett*., 227 (1979); Townes, C.H. *et al*., New Evidence on the Mass Distribution in the Galactic Center, *Nature*, 315, p. 767 (1985); Townes, C.H. *et al*., The Nucleus of our Galaxy, Rep. Prog. Phys., 57, p. 417 (1994); Townes, C.H. *et al*., Characteristics of Dust Shells around 13 Late-Type Stars, *Astrom. J.*, 107, 4, p. 1469 (1994); Townes, C.H. *et al*., Non-uniform dust outflow observed around infrared object NML Cygni, *ApJ*, 48, p. 420 (1997); Townes, C.H. *et al.*, Logic and Uncertainties in Science and Religion, *Scripta Varia 99* (Vatican City, 2001), pp. 296-309; Townes, C.H., The Berkeley Infrared Spatial Interferometer: A Heterodyne Stellar Interferometer for the Mid-Infrared, *Ap. J.*, 537, pp. 998-1012 (2000); Townes, C.H., Interferometry on Mira in the Mid-Infrared: Cyclic Variability of the Continuum Diameter and the Effect of Spectral Lines on Apparent Size, *ApJ*, 588, pp. 1064-71 (2003); N. Short, W. Fitelson, D. Hale, and C.H. Townes, Low Altitude Atmospheric Turbulence Characteristics at Mt. Wilson Observatory, *Proceedings of SPIE*, V488, 803 (2003); J. Weiner, D. Hale, C.H. Townes, The Variability of Late-Type Stars Diameters Measured Using Mid-Infrared Interferometry, *Interferometry for Optical Astronomy II*, Conferences, August 22-28, 2002, Waikolea, Hawaii, Proceedings of SPIE, Vol 4838. 172-180, 2003; J. Weiner, D.D.S. Hale, and C.H. Townes, Asymptotic Giant Branch and Supergiant Stellar Diameters in the Mid-Infrared, *ApJ*, Vol. 589, 976 (2003); S. Tevousjan, J. Weiner, K.S. Abdeli, D.D.S. Hale, C.H. Townes, Mid-Infrared Interferometry on Dust Shells around 4 Late Type Stars, *ApJ*, Vol 611, 466 (2004); J. Weiner, K. Tatebe, D.D.S. Hale, C.H. Townes, J. Monnier, M. Ireland, P. Tuthill, R. Cohen, R.K. Barry, J. Rajagopol, W.C. Danchi, The Asymmetrical Dust Environment of IK Tau, *ApJ*, 636-1067 (2006); K. Tatebe, A.A. Chandler, D.D.S. Hale, and C.H. Townes, Characteristication of Dust Shell Dynamics and Asymmetry for 6 Mira-Type Stars, *ApJ*, 652, 666 (2006); K. Tatebe, D.D.S. Hale, E.H. Wishnow, and C.H. Townes, Observation of a Burst of High-Velocity Dust from - Herculis, *ApJ Letters*, April, 2007.